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VOL. 13, No. 4 DECEMBER, 1947

Some Unusual Features of Seed Germination with Particular Reference to Subterranean Clover*

By

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Seeds have been classified into microbiotic, living for a period not exceeding three years ; mesobiotic 3-15 years ; and megabiotic 15-100 years. Longevity is governed by both heredity and environment. By manipulating the latter, especially during the storage period, the seeds of many species may have their viability prolonged or shortened. Thus some farm and garden seeds which do not normally survive for more than 15 years can have their dormant life prolonged quite appreciably by drying, sealed storage and the control of temperature and gaseous exchange. Details vary for different species, but −5° C. has been found a useful storage temperature under dry conditions which reduce the moisture content of the seed to 6-8 per cent. A contrast is provided by seeds of the bulrush (*Typha Muelleri*), which will keep well in water in jars with muslin covers but will deteriorate when stored dry.

Capacity to Survive Adverse Conditions.

Many plants have well developed xerophytic characteristics which enable them to withstand adverse conditions, but seeds provide probably the most remarkable examples of xerophytism. Dry seeds can be kept for some time without injury at a temperature of −210° C. even if the testa is perforated, and a long sojourn in a vacuum or in an atmosphere of carbon dioxide or nitrogen is not injurious. Extremely high temperatures may also be withstood without harm, most desiccated seeds being able to survive a temperature of 100° C. for one or two hours. Perhaps the severest test yet made has been with the seeds of lucerne, mustard and wheat whose coats had been perforated and thus made permeable. These seeds germinated after having been subjected successively to desiccation for six months, a vacuum for a year, and finally subjected to a period of very low temperatures, −190° C. for three weeks, followed by −250° C. for three days. If seeds behave in this manner, where do the difficulties of germination arise ? In dealing with this question I propose to discuss delayed germination rather than complete loss of vitality.

* From a Presidential Address to the Western Australian Branch of the Australian Institute of Agricultural Science.

Factors Influencing Germination.

The three major factors influencing seed germination are moisture, temperature and oxygen. Light is sometimes a fourth factor. The influence of moisture on germination needs little elaboration and it is sufficient to say that moisture is necessary to initiate enzymatic action within the seed and thus bring about the translocation of materials necessary for germination.

The most favourable temperature for germination varies appreciably for different species and often alternating give better results than constant temperatures. These different requirements have necessitated the preparation of schedules to be used by seed testing stations in order that tests may be conducted under uniform conditions in different countries.

Naturally there is a tendency for summer growing plants to be favoured by higher temperatures than those found most suitable for the germination of winter growing species. The standard temperature for Sudan grass is 32° C., while most clovers are tested at 20° C. Species such as *Paspalum* and Rhodes grass respond to sharp alternations and are subjected to 37° C. for 8 hours and 20° C. for 16 hours. An initial period at a low temperature, e.g. 5° C., has overcome some technical difficulties, and further mention of this treatment will be made when discussing subterranean clover and Wimmera rye grass.

In many cases the increased germination induced by various treatments is caused by the favourable effect the treatment has on diffusion of oxygen through the membranes of the seed. Excessive moisture curtails the oxygen supply and usually has an adverse effect on germination. One notable exception is *Typha latifolia*, which germinates poorly or not at all in air but is stimulated by a reduction in the oxygen content, a feature apparently associated with its natural habitat. Working with *T. latifolia*, Moringa[11] obtained 96 per cent. germination in an atmosphere of 40-80 per cent. hydrogen or nitrogen, while 20 per cent. oxygen depressed germination almost to 1 per cent. Quite a number of other seeds have been found to germinate satisfactorily under water with a very limited oxygen supply.

Light may promote or hinder germination. Gardner[5] reported that exposure to light increased the germination of *Rumex crispus*, but depressed that of *Datura stramonium*. Lettuce seeds frequently have a light requirement. This may be satisfied by continuous exposure to light during the germination period or by exposing the moist seeds to light before placing them in a dark chamber.

Even when these conditions of moisture, temperature, oxygen and light exist at their optimum, however, some viable seeds do not germinate and are termed dormant. Brenchley and Warington differentiate between two types of dormancy, "natural" and "induced". Natural dormancy is the condition already mentioned and is due to some morphological or physiological state of the seed that prevents germination, even in a favourable environment. Induced dormancy, on the other hand, is forced upon the seeds by some condition of the environment that is unfavourable for germination, such as the exclusion of oxygen supply resulting from deep burial in the soil. It is proposed to consider natural dormancy in some detail.

Causes of Natural Dormancy.

The causes of natural dormancy have been studied extensively and are considered to be due to one or a combination of the following factors :

(1) The possession of a thick or hard coat which prevents the intake of water and probably also of oxygen. This is the most frequent cause of long dormancy and many examples are found in the family Leguminosæ. In some species all the seeds are hard but more frequently only a proportion have this characteristic and there are varying degrees of hardness. In this way nature ensures the distribution of germination of a single crop over a number of years. In some cases the seed coats are readily permeable to water but are so firm that they prevent the expansion of the embryo. Crocker and Davis[2] reported that when the seeds of *Alisma plantago* lie in water the

embryo reaches little more than one-quarter of its imbibitional and osmotic swelling. The embryo thus lives in water for years restrained in its swelling by the seed coat, against which it exerts a pressure of approximately 100 atmospheres.

(2) The possession of coats, which, although not hard, interfere with the absorption of oxygen. The classical example of this type is the seed coat of species of *Xanthium* including the Bathurst burr (*X. spinosum*). It is considered that the germination of many other seeds is greatly influenced by the rate of the diffusion of oxygen through the seed coat.

(3) The presence of immature embryos. Full embryonic development is not always reached when seeds become separated from the parent plant. This development continues after the seed has fallen and several weeks or even months may elapse before maturity is reached. Some examples of dormancy due to an undeveloped embryo are the maiden hair tree (*Gingko biloba*) of such phylogenetic interest, and species of *Cotoneaster* frequently grown for ornamental purposes.

(4) The possession of an apparently mature embryo which must undergo certain changes before it will germinate. The necessity for this after-ripening period is apparent with most seeds of the Rosaceæ, including peach, apple, cherry and plum.

Gadd[4] has suggested that some cases of delayed germination may result from the cells of the seed covering remaining alive for a certain time after harvest and utilising the oxygen necessary to start the germination process in the embryo. He contends that only when the covering is dead, through desiccation or some other way, can the oxygen diffuse without hindrance and the seed be ripe for germination.

Methods of Overcoming Dormancy.

Methods used to break the dormancy and hasten the germination include scarification, treatment with chemicals, alternation of temperature, freezing and thawing, storing and placing under conditions favourable to after-ripening. It is proposed to discuss these methods as they apply to some seeds of economic importance to Western Australia.

Subterranean Clover (*Trifolium subterraneum*).

Subterranean clover seed production has developed into a useful industry in Western Australia, the average annual production of cleaned seed exceeding 500 tons. When the industry was in its infancy the high hard seed content of locally produced lines caused much concern and an investigation was conducted by the author[8] with the object of overcoming this difficulty. It was ascertained that the high percentage of hard seeds was quite natural, the average for hand cleaned seed

TABLE 1.

The Hard Seed Content of Dwalganup Subterranean Clover in the Four Years Following Sowing.

	Percentage Hard Seeds.			
	1942	1943	1944	1945
Yornaning:				
Plot 1 ..	56	77	89	84
Plot 2 ..	54	74	83	96
Plot 3 ..	54	73	80	88
Wagin:				
Plot 1 ..	63	64	67	86
Plot 2 ..	66	74	61	95
Plot 3 ..	51	75	71	96

being 75 per cent. and figures exceeding 90 per cent. were recorded. Subsequent investigations[10] have shown that in the harvest following establishment the hard seed content of hand-cleaned samples averages 50-60 per cent. and this increases over a period of several years until the peak figure is reached. This trend is shown clearly in Table 1, based on the hard seed content of three plots at Yornaning and Wagin receiving different manurial treatments. There is a ready explanation for this behaviour since a hard seed reserve is normally carried over and supplemented each year. This tendency may be modified, however, by a heavy seed production year, as shown by the Wagin plots in 1944.

We are now beginning to learn a little about what happens to hard subterranean clover seeds, both in the soil and under storage conditions. Hand cleaned seed and burrs originating from four different sites—Yornaning, Narrogin, Kojonup and Boyup Brook—were sown in replicated plots during the autumn of 1942. The numbers of seeds which germinated each year over the period 1942-1946 are shown in Table 2.

TABLE 2.

Germination in Successive Years of Dwalganup Subterranean Clover Seed Harvested from New and Old Pasture, and Sown in 1942.

Age of Pasture.	Locality.	Annual Germination (Per cent.).					Total Germination (Per Cent.).
		1942	1943	1944	1945	1946	
1 year.	Yornaning :						
	Hand cleaned	52	9	1	1	0	63
	Seed in burr	52	11	12	1	0	76
1 ,,	Kojonup :						
	Hand cleaned	43	16	0	0	0	59
	Seed in burr	40	14	6	0	0	60
10 years	Narrogin :						
	Hand cleaned	31	8	6	1	1	47
	Seed in burr	24	29	17	2	0	72
10 ,,	Boyup Brook :						
	Hand cleaned	13	25	13	4	0	55
	Seed in burr	13	28	22	1	0	64

It is apparent that although the germination of seed from the old pastures was not as high in the first season, the leeway was made up in subsequent years. In the case of the new pastures the initial flush in the first season was followed by much lower germination in the second and third season. Viewed from the seed angle the old pastures possessed better insurance against adverse conditions. An interesting feature is the greater final germination in each case of seed not removed from the burrs, indicating that the burrs aid the seeds in retaining their viability while the processes which eliminate the hardness are in operation.

In all cases a high proportion of the germination recorded for each year followed the first rains in the autumn, suggesting that the major reduction in the hard seed content occurs under field conditions during the summer months. In the soil the seeds are subjected to wide fluctuations of temperature and moisture and to the action of micro-organisms and soil chemicals, all of which undoubtedly play a part in overcoming hardness. With laboratory storage in closed (but not sealed) tins, variations in temperature and humidity occur but they are only of a moderate nature. It is interesting to compare the reaction of seeds under the two very different sets of conditions.

Since 1936, when twelve samples of commercial Dwalganup subterranean clover seed were stored in the laboratory, germination tests have been carried out at the beginning of each year. The results of these tests are shown in Table 3.

TABLE 3.
The Germination of Laboratory Stored Dwalganup Subterranean Clover Seed in Successive Years following Gathering in 1936.

Year Tested.	Germination Per Cent.	Hard Seeds Per Cent.	Dead Seeds Per Cent.
1936	58	37	5
1937	62	33	5
1938	60	35	5
1939	60	35	5
1940	56	40	4
1941	60	33	7
1942	61	34	5
1943	63	32	5
1944	59	33	8
1945	51	35	14
1946	50	33	17

The first significant decline in germination was revealed in 1945, when a corresponding increase occurred in the dead seed content. It is natural to expect a steady deterioration in germination from this stage. A most interesting feature is the uniformity in the hard seed content over a period of ten years, indicating that the initial degree of hardness was high. It is reassuring to the farmer to know that providing the seed is sound initially, under favourable storage conditions vitality is retained for a considerable number of years.

The aspects already considered prompt two questions: firstly, what morphological character of the seed renders it hard, and secondly, how can this hardness be eliminated or reduced to reasonable proportions in commercial lines of seed?

Morphology of "Hard" Seed.

Originally it was thought that hard seeds were surrounded by a coat of wax which prevented the entry of water. This theory has been disproved, and Lute[6] has demonstrated that in the case of lucerne the water intake is governed by the palisade layer, comprising the testa or seed coat. Paring away the cuticle produced no effect on the rate of water intake, but when the tips of the palisade cells were injured the seeds took up water rapidly, swelling occurring in a few seconds.

The significance of the palisade layer in the case of subterranean clover seed has been demonstrated by Aitken[1] in Victoria. This so-called Malpighian layer consists of cells elongated at right angles to the surface and having thickened walls at their outer ends. This thickening is due to suberisation, and where continuous, as in the case of hard seeds, prevents the entry of water. The junction between the suberised caps and the unsuberised walls below is distinguishable as a translucent refractive line known as the light line. The cause of this line has been shown to be due to the contact of substances of different refractive indices. When hard seeds become soft the moisture penetration usually occurs in one specific area, the strophiole. In this area the Malpighian cells are bent and apparently under increased tension with an associated greater sensitivity to splitting.

Reducing the Proportion of Hard Seed.

The investigation commenced in 1935 soon revealed that the hard seed content of commercial lines was almost entirely dependent on the type and adjustment of

machinery used for cleaning the seed, and the number of times the seed was passed through. The variation that can result from different machining is shown in Table 4.

TABLE 4.
Subterranean Clover.

Area.	Average Percentage Hard Seeds.	
	Hand Cleaned.	Machine Cleaned.
1	83	15
2	84	31 (Machine 1) 7 (Machine 2)
3	75	56 (Machine 1) 12 (Machine 2)
4	67	4

By taking samples at various stages of cleaning it was ascertained that the " decoater " provided the most effective single treatment for the reduction of the hard seed content. This machine, designed to remove the papery pods, usually consists of a cylinder faced with woven wire gauze revolving close to a concave fibrous surface such as provided by a coir door mat. Besides the abrasive effect there is a decided increase in temperature which could easily contribute to the reduction of the hard seed content. Machine 1 referred to in Table 4 did not include a " decoater ". The hard seed content of commercial lines now seldom exceeds 10 per cent., and in many cases is less than 5 per cent. One farmer with a very efficient " decoater " has, for a number of years, produced seed with an average germination of at least 97 per cent.

Besides the hard seeds just described, another type of dormancy occurs with subterranean clover. The seeds, given favourable conditions of moisture, temperature and oxygen supply, take up moisture and swell but the testa remains intact and neither the radicle nor the plumule appear. This condition, which occurs most frequently with newly harvested seed, is often referred to as semi-hardseededness. Although an experienced analyst can differentiate between a semi-hard seed and a dead seed, an appreciable emergence of the radicle is necessary before the seedlings can be satisfactorily subjected to an examination under ultra-violet light for strain differentiation.

The difficulty due to this unusual type of dormancy has been overcome in the laboratory by conducting the first three days of the germination test at 5° C. with subsequent incubation at 20° C. This treatment, with a few exceptions, gives rise to normal germination.

Drooping Flowered Clover (*Trifolium cernuum*).

Drooping flowered clover seed is produced in commercial quantities in Western Australia and provides an even more extreme example of a hard seed producing species than subterranean clover. The hard seed proportion usually exceeds 90 per cent. and figures as high as 99 per cent. have been recorded. As the seeds shed very readily, no threshing is necessary, and little abrasion results from the winnowing and grading. Again, the seed being very small, is less likely to be scratched or chipped than larger seeds during the machining processes.

Lines with such high proportions of hard seed are not satisfactory for sowing, and experiments were conducted by the author[7] with an Ames hulling and scarifying machine designed for the treatment of small seeds. This machine consists essentially of a cupped wheel which by means of rapid revolutions throws the seed against a

harsh "garnet paper" surface. By this means the germination was increased immediately from less than 1 per cent. to 47 per cent., with a corresponding reduction in the hard seed content.

The results of the germination tests with drooping flowered clover are summarised in Table 5.

TABLE 5.
Drooping Flowered Clover.

Sample.	Germination Per Cent.		Hard Seeds Per Cent.	
	16/3/32.	6/12/32	16/3/32	6/12/32
Original	1	1	99	99
Scarified (2,650 r.p.m.) ..	41	50	58	48
Sub-sample A, Scarified (2,870 r.p.m.)	47	58	51	40
Sub-sample B, Scarified (2,870 r.p.m.)	44	58	54	40

Wimmera Rye Grass (*Lolium rigidum*).

This species is becoming increasingly important in the lighter rainfall areas of this State. Some seed is produced locally, but many tons are imported annually from the eastern States, particularly Victoria. Germination tests conducted at the Perth Seed Testing Station have given very variable results. A good average germination for Wimmera rye grass seed is 85 per cent., but many lines with a satisfactory appearance, when tested early in the year (January-February), gave germinations under standard conditions of less than 30 per cent. in fourteen days. Complications arose when the same lines of seed tested in April and May gave vigorous germinations exceeding 80 per cent. This increase in both rate and degree indicated that an after-harvesting ripening period was necessary with some lines of Wimmera rye grass seed before a satisfactory germination could be expected. Although the physiological details have not been investigated, this example of dormancy appears to be due to an apparently mature embryo which must undergo certain changes before it will germinate.

Low germination in seed tested in January or February is not always due to dormancy and germination may deteriorate rather than improve during the subsequent few months. Thus it was desirable to evolve a testing technique which would give the potential germination of samples early in the season, i.e. to forecast their value when sown at the normal time. A number of methods were tried, including different substrata, increased testing temperature and pre-drying the seeds, but success was not achieved until the seeds were subjected to chilling at 5° C. for the first five days of the test, the remaining nine days being at the standard 25° C. This treatment provides germination results early in the season, which are virtually the same as those obtained by the standard technique several months later at the normal sowing time.[9]

Paspalum (*Paspalum dilatatum*).

Paspalum provides another example of delayed maturity. Germination immediately following harvesting is usually most unsatisfactory, but, if the seed is sound and is stored under suitable conditions for a few months a normal germination results. In the laboratory this dormancy has been overcome by moistening the seeds with a dilute solution of potassium nitrate and testing at alternating temperatures—16 hours at 20° C. and 8 hours at 37° C.

Natural Factors Inhibiting and Stimulating Germination.

Besides the various types of dormancy that have been described, germination can be inhibited by certain substances which occur naturally in close proximity to the seed. Evenari and co-workers[3] found this to be the case with tomato juice, the effect extending to all stages of tomato seedling development and being characterised by a reduced number of germinating seeds, a retarded rate of germination and seedling development, and a deformation of the seedlings. The effect varied with the concentration of the juice, disappearing at very low concentrations.

Schuck[13] believed that there is a growth inhibiting substance in lettuce seed, since after a sufficient number of seeds had been germinated in the dark on a cotton medium for ten days the germination of similar seeds was completely inhibited on this medium; but when the cotton was washed in water and again used as a substratum 98 per cent. of a similar lot of seeds germinated.

A different type of inhibition was investigated by Stout and Tolman,[14] who found that some lines of sugar beet seed may contain a toxic substance capable of reducing laboratory germination. This effect is known now to be due to free ammonia hydrolysed from the organic nitrogen compounds of the seed ball during the process of germination. It may be overcome by washing the seeds in running water whereby a laboratory germination figure comparable with that resulting in the field is obtained, thus giving a better indication of agricultural value.

It is now generally accepted that the roots of plants seldom excrete substances that are beneficial or detrimental to accompanying or succeeding crops. However, root excretion does occur and apparently in some cases serves a definite purpose. Thus Saunders[12] demonstrated that the host plants of the parasite witchweed (*Striga lutea*) exude from their roots a substance that is necessary for the germination of the witchweed seeds. The precise nature of the substance is not known, but it is easily destroyed by high temperatures and loses its activating power on exposure to the air.

From natural inhibitors it is a short step to the effect of external factors such as mixing with fertilisers, treating with hormones or subjecting to vernalisation, but these aspects are beyond the scope of this paper.

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Interchange of Scientific Personnel*

It is imperative that the fullest facilities be available for any agricultural scientist to move freely from one employer to another. Such free movement assists the profession as a whole, the employer and employee.

From the viewpoint of the profession, the free movement of agricultural scientists means free movement of ideas and correspondingly more rapid progress in research findings. Within particular organisations and even particular regions, specific lines of thought tend to develop. Nothing is more wholesome than the mental upheaval which can be created by the arrival of a " non-believer ", a worker from a group with a totally different approach to the problem. All workers have experienced the stimulus of a visit by an interstate professional colleague. Such stimulus can be enormously enhanced by free transfer of officers.

Many workers, and especially those with family responsibilities, have foregone professional opportunities because they have been unprepared to lose the protection for themselves and their dependents which service with a current employer has gained them. A worker's entire future may be stultified, both professionally and financially, because a better job, and one that he deserves, is virtually denied him. The agricultural scientist should be able to feel that the whole field of agricultural science throughout the Commonwealth is open to him.

Conversely the employer who refuses to recognise privileges which have accumulated with a previous employer cannot expect to secure the best potential applicant. He must realise that when a vacant position is advertised a suitable applicant may be debarred from making application because he realises that he will lose accrued superannuation rights, long service leave and other rights. Such an organisation tends to become a water-tight structure in which only the aged will gain reward.

Thus the research worker, the employer and the nation will each gain by any measures designed to permit the more ready movement of persons into and from any particular field of employment of agricultural scientists. This problem was discussed at the Annual General Meeting of the Australian Institute of Agricultural Science held at Adelaide in August, 1946, and resolutions seeking to procure free movement of scientists were adopted.

The movement of scientists was also discussed by the British Commonwealth Scientific Official Conference in London in November, 1946. It was resolved that " the Conference considers that the interchange of members of scientific staffs, both of research organisations, of universities and of government departments between different parts of the (British) Commonwealth is of vital importance to the maintenance and development of scientific research. The Conference accordingly urges government and university authorities to take active steps to secure the maximum of such interchange." The Conference passed a number of resolutions seeking to procure the greatest development of scholarship facilities, the ready temporary transfer of scientists and the " co-ordination of superannuation schemes for scientific workers throughout the Commonwealth " so as to facilitate the interchangeability of staff without loss of pension rights. The Conference " therefore commended to the favourable consideration of governments and through governments to universities and other institutions employing scientists, the modification, if necessary, of existing superannuation schemes or the adoption of new schemes, which will provide that a scientific worker leaving the employment of an institution . . . is able to preserve . . . the accumulated value for pension purposes of the service he has given."

* Report by the sub-committee appointed by Council (Messrs. C. M. Donald, convener, W. Ives, G. Helson) to report on the facilities for the interchange of personnel between employers of agricultural scientific workers.

The Conference was not able at this stage to do more than adopt general resolutions. Within Australia it will certainly remain the task of such bodies as the Institute to ensure that real action to facilitate the movement of scientists is procured.

Principal Employers.

The principal employers of Institute members are the Commonwealth and State Public Services, the Council for Scientific and Industrial Research, and the universities. An analysis of the membership made in 1935 showed the following distribution, a distribution which is probably not greatly altered to-day:

	%
Government Services (Commonwealth and States)	73
Universities	14
Commercial Firms	8
Private (farming, etc.)	5

Facilities for the transfer of personnel to and from commercial firms must necessarily remain poor or non-existent unless a national insurance scheme is introduced (see below). The position of officers moving to or from commercial firms is disregarded in this survey.

Consideration of Rights Accruing to Employees.

The principal rights commonly accruing to persons in government or university employment are superannuation rights, long service leave, sick leave and recreation leave. In general each of these employers has its own conditions in respect to the granting and the accrual of such rights. It must be freely recognised that so long as these employers retain their separate entities, it is unreasonable and indeed hopeless, to expect a complete unification of these conditions of employment. The Institute must have as its objective, not the removal of all differences in such conditions (though this would permit the easiest exchange) but the recognition and fair evaluation by any employer of rights accrued elsewhere by a new employee.

The present position in regard to persons transferring from the employment of any State to employment by the Commonwealth can be regarded as a satisfactory example of our objective. Superannuation rights, seniority, long service leave, sick leave and recreation leave are all recognised and "carried over". Certain conditions of carry-over are necessarily imposed but the general principle sought by the Institute is here already adopted. Most of the States extend no such reciprocity. (Unfortunately, however, the free movement of workers is in fact restricted because of an arbitrary agreement between Commonwealth and State Governments—see below.)

Of the accrued rights which any research worker might wish to hold when moving to a new employer, superannuation rights are of far greater importance than any others. Superannuation protects the worker and his family against his own incapacitation, and his dependents against destitution if he dies. It also ensures a sufficient income on retirement. There is provision in most services that accrued long service leave and current recreation leave can be "cashed" by the resigning officer, and though the transfer of these rights, rather than their surrender for cash, is certainly desirable, it is of less importance than the transfer of superannuation rights. Sick leave conditions vary widely—in some services sick leave is granted on a non-cumulative, annual basis—in other instances it may accrue until six months or more sick leave stands to the credit of the officer. This right cannot be cashed and its transfer must therefore be sought.

The Present Position.

The following text and charts reveal the current position regarding the transfer of rights between the Commonwealth and State Public Services, C.S.I.R. and the universities.

(1) Transfer of Superannuation Rights.

(*a*) *To the Commonwealth Service.* Officers of the Commonwealth Public Service and of C.S.I.R. both subscribe to the Commonwealth Superannuation Fund, and thus there is a continuity of payment in the case of an officer transferring from one organisation to the other.

Full provision is made for officers transferring from any State Service to the Commonwealth Service (including C.S.I.R.) to carry their superannuation rights (Superannuation Act (No. 2), 1945, Section 60A0).

No provision is made for transfer of superannuation rights from the universities to the Commonwealth.

(*b*) *To a State Public Service.* In no State other than South Australia is there provision for an officer to carry his superannuation rights from the Commonwealth Service or from any other State.

In South Australia the Superannuation Fund Act was amended in 1946 to give the Board power to make regulations prescribing conditions upon which employees transferred from the service of the Commonwealth or another State may become contributors to the South Australian Superannuation Fund. Hence it may be assumed that the Board proposes to make regulations along these lines.

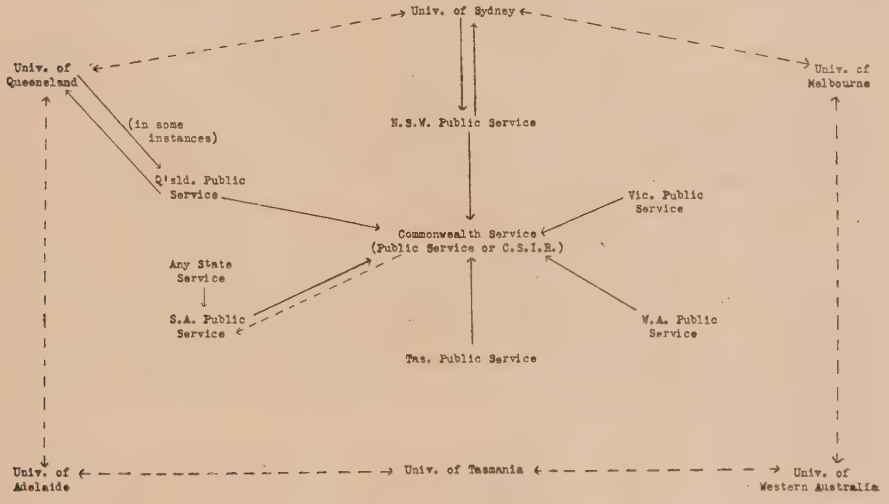

Figure 1.
Facilities for Transfer of Superannuation Rights.
Arrows show the direction in which rights may be carried. Where the line is broken it means that the facilities are in process of development or recognition (see text).

Only in New South Wales and Queensland can superannuation rights be carried from the University to the Public Service of the respective State. In these instances University employees may contribute to the State Public Service Superannuation Fund.

(*c*) *To the Universities.*

At the present time each University has its own superannuation scheme. The secretary to the Australian Vice-Chancellors' Committee, which is the co-ordinating body between the Australian Universities, reports as follows:

> "The question of common superannuation arrangements between the Australian Universities has now been under negotiation for some time, and the Vice-Chancellors of the Universities have generally agreed that the Universities should adjust their present schemes so as to bring their full-time permanent

staffs on a common scheme on the lines of the Federated Superannuation system for Universities in Great Britain. This system requires superannuation to be effected by means of assurance policies of approved types in certain approved companies, the policies being acceptable by all universities and institutions which belong to the scheme. The basis of the arrangement is that a member is required to take out such policies as may be purchased by premiums equivalent to 15 per cent. of his salary, of which one-third is payable by him and two-thirds by the employing institution.

"The University of Melbourne is now applying this system to all new members of its staff appointed after 1st January, 1947, and it is probable that several other Australian Universities will take a similar step in the near future. It is intended, once the joint Universities' scheme is working, that it should be open to other bodies employing scientific and academically trained personnel to join, although in many cases this may not be an easy step to take because of the operation of State and Commonwealth legislation. The F.S.S.U. scheme was chosen as a basis because it has worked very well in the Universities in the United Kingdom, and will provide a means of reciprocity between the Australian and British Universities in so far as staffs move from one country to the other. In England the D.S.I.R. and other scientific institutions belong to the University scheme.

"After 1st January, 1947, in so far as other Universities join the common scheme, it will be possible for new members of staff coming from such Universities to carry on as if their superannuation arrangements were continuous. It will, of course, be a long time before the University staffs include a high proportion of members who join after 1st January, 1947, and to that extent the system will be slow in coming into operation."

The current position in each of the Universities is as follows:

Sydney. At Sydney University officers appointed full time on an annual salary are obliged to contribute to the State Superannuation Fund under the New South Wales Superannuation Act 1916-44. If they already contribute to the fund they are able to carry their rights to the University. Professors are excluded from the State Superannuation Fund and come under the provisions of the Sydney University Professorial Superannuation System. This system is based on the Federated Superannuation System for Universities which operates in the United Kingdom (referred to above).

Melbourne. Officers joining the staff of the University of Melbourne had, until 31st December, 1946, to join the University Provident Fund as a new member of the staff and to comply fully with the obligations set out in the Agreement of that Fund.

Queensland. In the University of Queensland, the University Endowment Assurance Scheme provides that any permanent member of the staff shall contribute 5 to 10 per cent. of salary to meet the cost of life assurance cover payable at 65 years. All requisite cover may be taken out with either the State Public Service Superannuation Board or an approved insurance company. Thus officers transferring from the Queensland Public Service to the University of Queensland are able to carry over their superannuation rights.

Adelaide. The University of Adelaide introduced a scheme in 1935 on lines similar to the English Federated Superannuation System for Universities. The scheme, however, is not identical with the English scheme, which provided for deductions being made on salaries up to £2,000 per annum, whereas in Adelaide at the present time the maximum contribution by the University is £100 per annum, the member contributing a maximum of £50 per annum. (These figures are being reviewed following an increase in professorial salaries at the University of Adelaide.) Professors arriving from England who held policies under the Federated Superannuation Scheme have had their policies transferred to the Adelaide scheme, and in

like manner members of the Adelaide staff have been able to transfer their policies to the F.S.S.U. Scheme.

Western Australia. The University of Western Australia has a closely similar scheme, but it is applicable only after a staff member has been employed twelve years. An attempt is being made to bring the system into operation immediately on appointment, the final decision in this matter resting with the State Government.

Tasmania. At the University of Tasmania appointees are required to take out endowment policies maturing at the age of 65 years. Premiums total 10 per cent. of salaries, half being paid by the employee and half by the University. Any person leaving an institution of which the superannuation scheme depends upon insurance is likely to transfer easily to the Tasmanian University Scheme.

Summarised, the only existing facilities for the transfer of superannuation rights to the Universities from government services are from the New South Wales Public Service and the Queensland Public Service to the Universities of Sydney and Queensland respectively. Adoption of the Australian Universities Superannuation Scheme will permit free carriage of superannuation rights from one University to another (a procedure now only possible between Universities on closely similar schemes based on private insurance) but would presumably prevent the avenues of State Public Service-University transfer at present possible in New South Wales and Queensland.

(2) Transfer of Long Service Leave.

(*a*) *To the Commonwealth Public Service and C.S.I.R.* Permanent officers of a State Public Service may be appointed to the Commonwealth Public Service and be credited under section 48 of the Commonwealth Public Service Act with their State service (temporary and permanent) for purposes of long service leave if it is continuous with service in the Commonwealth. Regulation 14 of the Science and Industry Research Regulations similarly recognises the period spent in any State service or in the Commonwealth Service or in the Naval, Military and Air Forces of the Commonwealth in the computation of long service leave within C.S.I.R. Again service must be continuous. Neither the Commonwealth Public Service nor C.S.I.R. make any provision for the transfer of long service leave from any of the Universities.

(*b*) *To a State Public Service.* No State makes provision for the transfer of long service rights from any University.

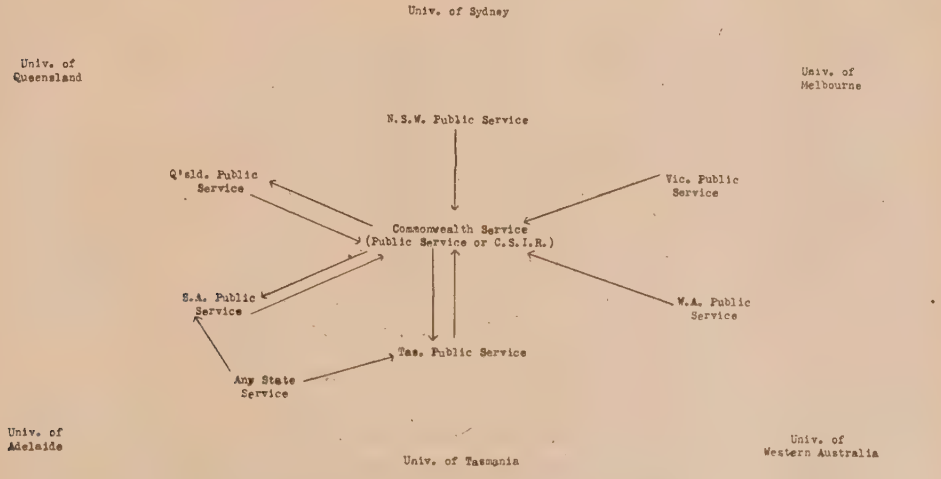

Figure 2.
Facilities for Transfer of Long Service Leave.
Arrows show the direction in which rights may be carried.

No provision is made in New South Wales, Victoria or Western Australia for the transfer of long service rights from any other organisation. In Queensland credit may be given at the discretion of the Public Service Commissioner for any immediate previous service with the Commonwealth Public Service or C.S.I.R. The Public Services of South Australia and Tasmania each recognise previous service with another State or with the Commonwealth in the assessment of long service leave.

(*c*) *To a University.* No University recognises long service leave rights accrued with any other organisation. It is reported, however, that this subject is under review at the University of Adelaide.

(3) Transfer of Sick Leave and Recreation Leave Rights.

(*a*) *To the Commonwealth.* The Commonwealth Public Service and C.S.I.R. each specify conditions permitting the transfer of these rights from any State Public Services. (Section 48, Commonwealth Public Service, and Clause 14A (3), Science and Industry Research Act). These rights cannot, however, be transferred to the Commonwealth Service from any University.

(*b*) *To the State Public Service.* New South Wales, Victoria, Western Australia and Tasmania do not accept transfer of recreation or sick leave rights from any other organisation. The South Australian Public Service allows employees to count previous service with the Commonwealth or with any State Service for recreation and sick leave purposes.

In Queensland no recognition is given to service in the Public Service of other States or of any University. It is not generally allowed in the case of prior Commonwealth service, but the decision here depends upon the circumstances of each case.

(*c*) *To the Universities.* No University makes any provision for the transfer of recreation or sick leave privileges from any other University or any government service.

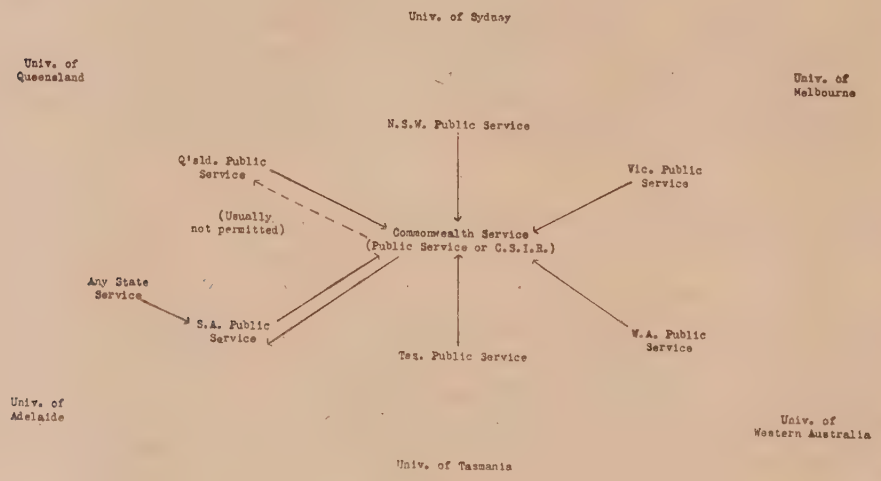

Figure 3.
Facilities for Transfer of Recreation and Sick Leave.
Arrows show the direction in which rights may be carried.

Action Recommended.

If freedom of movement of agricultural workers is to be realised, each important employer must recognise rights accrued in the service of other employers. The precise steps needed may be enumerated as follow:

(*a*) *Participation in the Australian Universities Scheme by all Australian Universities.*

As indicated above, there are good prospects of entry into this scheme by each of the six Australian Universities. The scheme will not necessarily cover the entire staff of all Universities, but it will cover all those joining a University staff from the date at which that University enters the scheme. The superannuation schemes of some of the Universities (e.g. Adelaide, Western Australia) are already such that contributors are readily absorbed into the wider scheme.

If the scheme is accepted by all Universities, it remains to seek examination by the Universities of the possibility of transfer of accrued long leave, sick leave and recreation leave privileges. The Universities are, generally speaking, liberal in respect to sick leave and recreation leave. For example at the University of Western Australia recreation leave is taken during vacations at the discretion of the officer. The principal aspect other than superannuation is thus the transfer of long service leave, and agreement on this matter between the Universities might perhaps be achieved by basing long service leave on the period for which the officer has contributed to the all-Universities superannuation scheme.

In the case of an officer transferring to a University from government employment, it is likely that the lump sum paid him on resignation from the Public Service would be adequate to permit him to take out appropriate cover in conjunction with the Universities Scheme.

(*b*) *States to Accept Rights Accrued with the Commonwealth or with the States.*

A clear precedent is here set by South Australia. In that State an officer transferring from any other State Public Service or from the Commonwealth is able to transfer his long service, sick leave and recreation rights. Under the 1946 amendment to the Superannuation Act the Board now has power to make regulations prescribing conditions under which employees transferred from the service of the Commonwealth or State may become a contributor to the South Australian Superannuation Fund.

It remains to seek the adoption of amendments to the legislation of each of the other five States whereby rights can similarly be carried into their service from other services. Those States which do not take such steps will inevitably be the losers as regards recruitment of qualified personnel.

It is recommended that the Institute make representations to the Australian Agricultural Council to seek appropriate amendments to State legislation in these five States.

(*c*) *States and Commonwealth to Recognise the Universities Superannuation Scheme.*

With the adoption of a common Universities Scheme, there will remain the problem of the recognition of the scheme by the Commonwealth and State Governments; the provision of machinery for the transfer in either direction of superannuation rights may be difficult because the Universities Scheme, based on insurance with private firms, will be basically different from that of the Commonwealth and State Services. Nevertheless it is known that C.S.I.R. is interested in facilitating staff movements between C.S.I.R. and the Universities. No specific action can be taken until all Universities affirm their entry into the Australian Universities Scheme.

Transfer of other rights may be less easily accomplished but these are of less consequence and their loss is not likely to deter a worker from transferring.

(*d*) *Other Measures.*

It is necessary to encourage among all principal employers of agricultural research workers the fullest recognition of the desirability of freedom of movement of such workers. This means not only that they should make provision for the transfer of rights to their own services, but that they should place no impediment in the way of an officer wishing to leave their own service. Such impediments certainly exist in many instances. (The committee does not refer here to bonds entered by University

trainees to serve a particular State service on graduation. The State is entitled to ensure a return for money spent in assisting a student through the University under favourable conditions.)

Instances came to the notice of the committee which appeared to be direct and unwarranted interference with the liberty of the individual. For example, there is a " gentlemen's agreement " between the Commonwealth and C.S.I.R. on the one hand and the State Public Services on the other whereby the Commonwealth shall request the release of any officer who has successfully applied for a post with the Commonwealth. If the State refuse to release the officer (shades of the Manpower Directorate) then that officer is denied the opportunity to change his employer. The question of transfer of rights does not arise—he simply becomes another unsuccessful applicant.

Various members report a general lack of sympathy in their States towards projected movements by officers and this attitude is commonly reflected as a tendency to make transfer from their service as difficult rather than as trouble-free as possible.

The Implications of National Insurance.

The foregoing analysis has shown that by far the greatest problem in facilitating transfers of officers from one field of employment to another is that of loss of superannuation rights due to the need for winding up participation in one scheme and joining a new one.

The need for superannuation could be reduced considerably by the introduction of universal old age pensions. When old age pensions were first paid by the Commonwealth forty years ago they were paid at a very low rate and were subject to a rigid and humiliating means test. At the present time, however, the rate is £1 17*s*. 6*d*. a week for both males and females, the pension being payable at age 65 and 60, respectively. Thus man and wife receive £3 15*s*. per week and at the same time are permitted to own their own home (of any value) and to have up to £650 in the bank. This represents a reasonably secure though by no means affluent position.

The Commonwealth Government has announced its intention to investigate the possibility of establishing a national superannuation fund. No details have been released, and presumably such a scheme might not operate for many years. However, the Minister for Social Services is reported to have stated that " there would be no worsening of existing superannuation funds, whether governmental, semi-governmental or private ". A major modification of many schemes is however inevitable under a national scheme. It seems reasonable to assume that payments under National Superannuation would not be less than the present old age pensions.

Thus the existing problems of transfer of personnel may (in respect at least to superannuation rights) be removed by a single legislative act by the Commonwealth. It is nevertheless the view of the Committee that pending more definite information on the national scheme the alternative steps proposed in the foregoing section be explored. If there were a reasonable prospect of the national scheme being introduced within two or three years the importance of the Institute taking action would be correspondingly reduced.

The Wheat Industry and Wheat Research in New Zealand

By

J. R. Fisher,

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Wheat growing in New Zealand is very largely confined to the South Island, chiefly in the eastern regions of the Province of Canterbury, with Ashburton, 54 miles from Christchurch, the principal wheat growing centre. The administrative offices and cereal laboratories of the Wheat Research Institute are located in Christchurch, one of the four principal cities of New Zealand, and it is thus able to maintain close liaison with the wheat industry and with the milling and baking industries.

At the present time New Zealand does not produce sufficient wheat to meet her own requirements ; production of wheat has averaged 7·3 million bushels per annum over the last decade, whereas home consumption requirements at present are 12·5 million bushels. This position exists notwithstanding the fact that New Zealand wheat growers have received a higher price per bushel than Australian growers, and that the average yield is 33 bushels per acre compared with 11·5 bushels in Australia. The principal reason for this is that high prices are received for other agricultural products.

The Wheat Industry.

Soils.

On the whole the soils on which wheat is grown are relatively shallow, overlying shingle brought down from the Alps by rivers. The soils consist of silt deposited subsequently, and vary in texture from light to heavy silts. As the soils are relatively shallow, some being no more than ten inches in depth, and overlying shingle, their water-holding capacity is not good by Australian standards, and crops suffer adversely when the weather remains dry for even short periods. The poor water-holding capacity of the soil, however, is offset by the reliability and even distribution of rainfall throughout the year ; the eastern portion of the Province of Canterbury receives from twenty to thirty inches of rain per annum.

Farming programmes in the wheat areas are designed with the object of maintaining maximum soil fertility, wheat being grown only when it is considered that the general fertility of the soil is sufficiently high to justify taking a cash crop. The general level of fertility of New Zealand wheat soils is maintained at a higher level than that of most Australian wheat-growing soils by the adoption of rotations designed to improve fertility.

Rotations.

Success of the rotations adopted in New Zealand is very largely a result of the reliability of the rainfall and its even distribution throughout the year, combined with the high monetary returns obtained from live-stock and from crops other than wheat.

The view is held in New Zealand that not more than one crop of wheat should be taken from the land in five years if soil fertility is to be maintained at a high level ; on some of the heavier soils two successive wheat crops may be grown, but in such instances the yield from the second crop is almost invariably lower than that from the first. Rotations adopted usually consist of sown pasture for not less than three years, during which time financial returns may be obtained from grazing, pasture

* Mr. Fisher spent eight weeks in New Zealand early in 1947 studying wheat research facilities and organization in that country.

hay, or grass and clover seed. Pasture is followed by a crop such as rape, peas, turnips for stock feed, or in some instances potatoes, grown to improve the physical condition of the soil for the following year's wheat crop. One of these crops may also be grown following wheat before the land is sown to pasture again.

In addition to the beneficial effect of grazing animals on pastures containing clover, liberal applications of lime and artificial fertilizers to crops assist in building up the general fertility of the soil. One ton of lime per acre is usually applied prior to sowing down to pasture and superphosphate is used extensively with almost all crops.

The acreage sown to wheat tends to follow inversely prices received for fat lambs, grass and clover seed, and yields of wheat per acre tend to be positively correlated with increased use of agricultural land for grazing purposes. At the present time very high prices are received for grass and clover seed, with the result that many sown pastures that would normally be used for grazing are used for seed production.

Seed Certification.

Seed certification schemes are provided by the Department of Agriculture for most agricultural seeds, including cereals, grasses and clovers. Three grades of certified seeds are recognized: (1) Certified Pedigree Seed; (2) Certified Mother Seed; (3) Certified Standard Seed.

Areas sown with Certified Pedigree seed are eligible to produce Certified Mother seed, and areas sown with this latter grade are eligible to produce Certified Standard seed. Areas sown with Certified Standard seed are not eligible for re-entry into the certification scheme, as this grade is intended for sowing areas for commercial grain production.

Certified Pedigree wheat seed is produced by the Agronomy Division of the Plant Research Bureau or by Canterbury Agricultural College from stocks supplied by the Agronomy Division, and the other two grades are grown by farmers and the crops inspected by officers of the Department of Agriculture. By adopting this certification scheme the amount of Pedigree seed required is relatively small, and sufficient seed of satisfactory purity is assured for commercial grain production.

Quality of New Zealand Wheat.

Limiting the term quality to the protein content of the grain and protein quality, the quality of wheat in New Zealand does not vary to the extent that it varies in New South Wales in any one season, nor does it vary so greatly from year to year. However, other factors such as sprout damage may affect the overall quality of New Zealand grain.

The protein content of samples grown on various soil types and in different localities in New Zealand does not vary more than about two per cent., whereas in New South Wales the range is very wide. Whilst climatic conditions in the wheat growing areas of New Zealand do not vary to the same extent as those of the wheat growing areas of New South Wales, the range in protein content is nevertheless remarkably small. It would appear that the nitrogen status of New Zealand wheat soils is built up to such an extent by rotational farming that the soil nitrogen does not enter as a limiting factor in respect of protein content of the grain. The protein content of average New Zealand wheat is considered to be slightly lower than that of New South Wales F.A.Q. wheat, although some New South Wales wheat would be of lower quality than average New Zealand wheat.

There has been a general upward trend in the protein quality of wheat in New Zealand in recent years owing to the introduction of improved varieties. Cross 7, a variety developed at the Wheat Research Institute, has replaced Tuscan in many areas, and brought about a general improvement in quality. At present the Institute has a promising new variety under trial. This new variety, known as 140.014 from the cross Tainui × Cross 7, is claimed to contain about two per cent. more protein

than other New Zealand varieties, and in protein quality is about equal to good samples of Kendee grown in New South Wales.

The Wheat Research Institute.

The Wheat Research Institute is controlled by the Department of Scientific and Industrial Research, and is financed partly from a levy on farmers, millers and bakers, and partly by the Government as representing the consumer. The functions of the Institute embrace research and extension work designed to improve the quality of wheat, flour and bread.

Wheat breeding is conducted at Lincoln on land leased from Canterbury Agricultural College, the genetical laboratories and a glasshouse for winter cultivation of cereals being situated in the College grounds. The genetical staff of the Institute is concerned primarily with improving the New Zealand wheat by breeding varieties with higher baking quality and superior agronomic characteristics to those at present grown commercially. Since wheat "stem rust" is not prevalent in New Zealand as it is in parts of New South Wales, breeding programmes are not based on "stem rust" resistance, but the Institute proposes to initiate programmes in the near future to develop varieties resistant to "mildew" and "leaf rust".

As harvesting is often interrupted or delayed by rain, there is a danger that wheat may be stripped when the moisture content is too high for safe storage. To provide advice to farmers on the condition of the grain for harvesting, the Institute maintains during the harvesting period a number of moisture testing stations throughout the wheat areas.

Flour Extraction in New Zealand.

The rate of extraction of flour was raised in New Zealand from the normal 72 per cent. for white flour to 80 per cent., in May, 1946, with the object of reducing the amount of grain imported into the Dominion. This change necessitated modification of both milling and baking technique in industry, because flour of 80 per cent. extraction requires more careful handling in the bakehouse than white flour of 72 per cent. extraction. The Institute was in a position to advise the industries on the changes necessary as prior to raising the extraction rate experiments had been conducted with the object of improving the nutritional value of flour by incorporating some of the high vitamin fractions removed in the offal under normal milling procedure of 72 per cent. extraction.

Vitamin content of 80 per cent. extraction flour compared with that of 72 per cent. extraction is shown in Table I.

Table I.

Extraction.	Vitamin B_1.	Riboflavin.	Nicotinic Acid.
72 per cent. ..	1·8 p.p.m.	0·5 p.p.m.	11·0 p.p.m.
80 per cent. ..	3·1 p.p.m.	0·7 p.p.m.	16·0 p.p.m.

To recover the vitamin-rich fractions from the offal, a "centrifugal detacher" had been developed at the Institute, and when the rate of extraction was increased, these machines were installed in commercial flour mills to assist in achieving the additional extraction.

(Received for publication, 24th July, 1947.)

The Sixth Report of the Rural Reconstruction Commission

FARMING EFFICIENCY AND COSTS.

This Report comes nearer than any of its predecessors to a study of the managerial problems of the individual farm, although earlier reports have discussed the financial aspects of farm management.

In the Report " . . . the main factors governing agricultural efficiency have been divided into two groups. First, those connected with the actual working of the farm itself, with the education of farmers and with the general co-ordination of agricultural policy in the national structure. Secondly, those factors (excluding the cost of credit) which influence the farmer's costs of production, but over which he has little or no control."

The field covered is wide. The Commission, however, is careful to point out that it is under no " illusions that the success of farming is entirely governed by technical efficiency and the other matters referred to in this report. Finance, land tenures, markets, prices and other influences all contribute to a successful agriculture."

The reader's attention is drawn to other reports in which these subjects are discussed.

Farm Efficiency.

This chapter, covering eighteen pages, is noteworthy for the division of a farm's development into four stages, each of which is described. In the first stage the vegetation is wholly or partially cleared, the property is developed by fencing, and other improvements such as the erection of a house and buildings are made. The second stage commences when the " inherent fertility has been reduced and pastures or crops are less successful ". Declining fertility, if allowed to proceed unchecked, causes disappointment to the farmers and the less stable of them move out of the district. " Enterprising souls who, dissatisfied with their conditions, search steadily for a way out of their dilemma ", may move into the third stage. The problem presented is one of maintaining soil fertility, for no system of agriculture which does not ensure the maintenance of soil fertility can be stable. The solution is to some extent dependent upon the agricultural advisory and financial services available to farmers. Each of these is discussed elsewhere by the Commission, but the pause to point to the significance of these factors in the evolution of each individual farm is timely. Passage through this stage is dependent upon a recognition by the farmer that progress will follow a change in methods, which must be appropriate to the individual farm. The farmer's financial viewpoint should also be recognized—better the devil of low productivity which he knows than the unknown devil of new methods which increase costs without any guarantee of increased productivity.

The farmer who is fortunate and skilled enough to reach the fourth stage has developed a stabilized system of agriculture ; all details of management are attended to, and the farm is fully developed.

Emphasis on these four stages is designed to draw attention to the need for an efficient extension service. " What is necessary is an extension service staffed by officers who understand the principles in full, and have some knowledge of the scientific foundations on which they rest and a real knowledge of the intricacies of managing a farm." The farmer himself should also be able to recognize the stages, so that his progress can be facilitated.

Some examples of evolution on actual farms are quoted by the Commission. Lack of details regarding changes in financial position accompanying the description of agricultural development is unfortunate. Without in any way querying the wisdom of the development carried out in the examples quoted, one is reminded

of the old quip, " If a man has pasture enough for ten cows, he should keep twenty. He will get almost as much milk and have more cows ! "

Mechanization on the Farm.

The discussion of the usefulness of mechanization in relation to farming efficiency is an excellent outline of the general principles which underlie mechanization in Australia.

The tractor versus horses argument is raised. The conclusions recorded are : " . . . the essential points in deciding the merits of a tractor as opposed to horses are, first, whether the time at which the operation is carried out is of vital significance ; secondly, the size of the farm ; thirdly, whether there is suitable grazing land and water supply for horses available ; and fourthly, the capacity and knowledge of the farmer himself." The problem can be solved by considering the conditions peculiar to each individual farm ; it is not possible to generalize unless one factor, such as the importance of timing in cereal cropping, is all-important. Even then the advantage of mechanization can be offset by a farm too small to use the machine to full capacity, or by the farmer's ignorance of internal combustion engines.

The need for further development in mechanization is emphasized, especially to reduce costs of clearing, cotton harvesting, forage harvesting, and to increase efficiency in the dairy industry. The need to modify agricultural operations, crops, cows, and even size of farms to take full advantage of mechanization receives well-deserved emphasis. Zealous salesmanship, hire purchase agreements, and standardization are discussed.

The main theme of the Commission's views is crystallized in its recommendations which draw attention to the need to incorporate the advantages of mechanization in agricultural operations, and yet to avoid over-investment, in which case the " charges exceed the gains from the amount of work which the machine can be reasonably expected to perform ". It is also recommended that the Council for Scientific and Industrial Research should " be asked to approach the States to ascertain whether they are prepared to co-operate in setting up an organization to study the use of machinery in farming ". Suggestions are made as to appropriate urgent fields of study for such an organization. Finally the Commission recommends that each State Department of Agriculture should provide a small extension service dealing specifically with farm machinery and mechanization.

Technical Education and the Farming Industries.

The Commission is not deterred by the immensity of the problem nor by the Commonwealth's limited powers in regard to education. The various stages are surveyed, the Commission noting in the introduction that " the importance of a sound general education to those who ultimately follow technical pursuits cannot be overstressed ".

Emphasis in the primary stage with its " tendency to enshrine the city with its speed, its mass achievements and its facilities, as the focal point of all interest " is wrong and there is need for a new outlook so that education towards country life shall be a main objective, with both craft and biological training introduced.

In the high school stage there has been a division of schools into agricultural, technical or the general high school established in cities. The Commission " considers it most unlikely that the attachment of a small farm to an agricultural high school will be satisfactory from the educational standpoint . . . a farm is not a necessary part of an agricultural high school for the purposes of teaching practical agriculture ". Visits to farms in neighbouring districts provide the necessary practical demonstration, while farming practices can best be learnt on a commercial farm. The Commission considers that the high schools should accept responsibility for the basic training of farmers, who would then be topped off by experience on farms, and in some cases by more advanced education at the agricultural colleges.

The agricultural colleges " could be the intermediate stage of training between the agricultural high school or country technical school, on one hand, and the university on the other ". The Commission envisages greater emphasis on the crafts and biological subjects at high schools, leaving the colleges to provide more advanced instruction in basic sciences and farm management. The Commission emphasizes its view that " the proper place to learn farming procedures is on a commercial farm ", and colleges should " provide for much more study in the lecture room and the laboratory than has been customary ".

The university phase of education is discussed, and the Commission mentions the problems associated with the choice between a broad training in basic sciences and specialization. The Commission's vote goes to a broad training in the undergraduate course, and it states the worthy ideal that " specialists would be recruited by affording opportunities for post-graduate research . . . by means of a liberal scheme of research grants ". The problems associated with training veterinarians are mentioned. The Commission suggests that college diplomates be used for stock inspection and other less skilled aspects of veterinary work, leaving the veterinarian free for more skilled tasks.

Educational Services for Farmers.

The staff available for extension work among farmers is inadequate in each State, possibly excepting Tasmania. The Commission underlines its belief " that the whole problem of agricultural reorganization in Australia depends on the success with which this need is met ". The requirement for extension officers is estimated to be one for each 600 farmers in well established districts, and one for each 300 farmers in a newly settled or backward district. The total cost of such a service would not exceed £500,000, including the cost of " the present inadequate services, which probably cost about £250,000 ". The cost is small in comparison with that of bounties and home consumption schemes, stated by the Commission to exceed £10,000,000. The need for some such subventions should disappear if a properly staffed advisory service were set up.

A special plea is made for a recognition of the importance of advisory workers competent to advise regarding animal husbandry and also home management.

The experiment farms in the States receive special mention. " Some are wretchedly equipped . . . on some experiment farms the management was not impressive . . . Probably there has been insufficient experiment in the problem of raising and maintaining soil fertility by radical changes in the whole farming system."

The usefulness of agricultural shows, and the dangers of concentrating on appearances and neglecting performance are mentioned. Comments on other media by which advisory work can be carried out are made, including the Agricultural Bureau, Young Farmers' Clubs, wireless and publications.

In its recommendations the Commission takes the only approach possible in view of the Commonwealth's limited powers. The Commonwealth, by conditional grants-in-aid, should encourage the policy mentioned by the Commission.

The introduction of more craft training in primary schools, the development of curricula suited to country life, the development of rural technical training in technical and other high schools in country districts, and the extension of biological subjects at all stages of education—all of these are to be stimulated by grants-in-aid and indirect assistance such as provision of books and the construction of educational films. Similarly those States prepared to specify entrance standards and introduce approved curricula and equipment into their agricultural colleges may be assisted by financial grants.

The significance of the Commonwealth's limited powers and of the indirect control it can exercise by virtue of its prior right of taxation and subsequent control of funds will not be lost to the student of public administration.

Important general recommendations are made, pointing to the need for research to devise agricultural systems which are less exploitative in character, in districts where soil fertility is declining. The Commission suggests that the Commonwealth and the States should tackle the problem of devising less exploitative agricultural systems, and that the Commonwealth should summon a conference of all interested parties to attempt to " devise a scheme of improving the training of personnel for investigation and extension work in connexion with the animal industries ".

Co-operation.

The development of co-operation in overseas countries is traced. Emphasis is laid on the dangers of regarding co-operatives as a cure-all of economic ills and of allowing inefficiency to enter the management owing to shortsightedness of farming directors, for " not every farmer, however worthy or successful as a farmer, will make a good director of a processing plant or business undertaking ".

In the various States the legal significance of " co-operative " varies, and the Commission suggests that a review be initiated in an attempt to ensure uniformity of use of the word " co-operative " throughout the Commonwealth. The Commission's recommendations refer to indirect methods by which the co-operative movement could be encouraged. They include provision to promote investigational, instructional and financial facilities for the benefit of co-operative organization in rural industries. The State Governments should be responsible for investigation and research, acting in collaboration with State rural finance organizations. The Commonwealth should undertake international and interstate investigations, and provide information services for State Departments. The State should make provision for loans to co-operative companies within their boundaries, and the Commonwealth for Commonwealth-wide societies.

Administration in Relation to Agricultural Efficiency.

" The general policy of the nation towards its agriculture is decided by Parliament and incorporated in laws which are intended to further agricultural development. This objective will be reached according to the wisdom of the laws and their accompanying regulations and also according to the intelligence and efficiency with which they are put into force."

The Commission divides its discussion as follows :

(*a*) Co-ordination of general agricultural policy.
(*b*) Nature of controls and their administration.
(*c*) Co-ordination of extension and research work.

(*a*) *Co-ordination of General Agricultural Policy.*

The Commission's guns are trained heavily on the Australian Agricultural Council and its *enfant terrible,* the Standing Committee on Agriculture. The infrequent meetings, the inadequate attention to particular problems of States, arising from the dominance of inadequately trained Commonwealth officers on the Secretariat, are mentioned. The tendency to rush through proposals, mistrust between Commonwealth and State representatives, lack of authority held by delegates and the need to consider matters which are more properly the responsibility of other departments are all listed on the debit side.

But the comment is not all negative. The Commission draws attention to an earlier recommendation regarding the establishment of a Land Utilization Council in each State, to co-ordinate all phases of land use in that State. Such a body could meet and advise the State representatives who are to attend Agricultural Council meetings of the State's overall policy and its effects on the agenda items listed.

The problem of resuscitating the Standing Committee on Agriculture remains. Wartime representatives should be removed, meetings should be held at least

quarterly, details of agenda items should be circulated in advance, and State departmental heads should be relieved of administrative duties by further decentralization. The Commission's report was presented over two years ago, but little improvement in the position appears to have been made.

(*b*) *Controls and Their Administration.*

Instances of bad administration of good laws and of attempts to administer bad laws are cited.

How will the scheme affect the farmer? That is the underlying theme of the discussion. The need for campaigns to educate farmers regarding controls to be imposed and the necessity for administrators to maintain close touch with farming conditions are noted.

Past experience of inefficient administration leads the Commission to develop an important recommendation—that the staffs of agricultural departments should be expanded for educational and regulationary purposes. The alternative cost to the nation, says the Commission, is to " provide much larger funds to enable its agricultural industries to stagger along under the system of hand-to-mouth bounties and subsidies which has distinguished the last fifteen years ".

Staff depends upon salaries and status, and the Commission, after recording the fact that it received representatives from the Australian Institute of Agricultural Science, sets out its views. Among these is the suggestion that the graduate's starting salary be related to the adult basic wage. It should be £75 p.a. above the wage for graduates who have done a three year course, and £100 above for graduates from four year courses.

(*c*) *Co-ordination of Extension and Research Work.*

The next aspect of administration which the Commission considers is the subject of the co-ordination of extension and research work. The discussion centres around the basic need to replace agricultural systems of an exploitative nature by systems of land usage which are more intensive and yet less wasteful.

The need for and desirability of joint research efforts by these organizations is emphasized. Pasture types in north-east Australia, an economic rotational system for summer crops, irrigation for the beef industry in northern areas, drought feeding, rural sociology, dairy farm management, agricultural statistics, and other problems are all suggested as being suitable " projects in which State and Commonwealth officers would work as a team for each specific research or investigation ". A strong recommendation that this co-operative approach between the Council for Scientific and Industrial Research and State Departments be developed further is made.

The second part of the Report is devoted to " those factors (excluding the cost of credit) which influence the farmer's cost of production, but over which he has little or no control ".

Cost of Fertilizers and Other Materials, and Related Problems.

This chapter is introduced by a brief discussion of the farmer's costs, and the relative importance of various cost items on different farms is set out.

A description in general terms of the importance of fertilizers in Australia is given. The discussion of costs of fertilizers and other farm materials is somewhat restricted, but the Commission points out that the limitations of staff as well as the uncertainty of the position in April, 1945, make a more detailed survey impracticable. The Commission recognizes, however, that these factors determine the welfare of agriculture and " emphasizes that the important point is the relationship of the trends in costs of farm requisites to the trends in prices of farm products, and further, that what happens to such trends in other countries is of great importance to

Australian agriculture ". The question of prices and income stabilization is left for consideration in a later report.

Based on this discussion, the Commission recommends that the Commonwealth should stabilize the price of superphosphate at the level expected to prevail, say, five years after the cessation of hostilities. Further, geologists engaged in the survey of mineral resources should give particular attention to areas where phosphate may occur ; and a close check should be maintained by the Prices Branch of prices for mixed manures.

Farm Wages.

The Commission's discussion centres around the possibilities of an award wage for rural employees. The reasons why such an award was not introduced in the past are noted.

The recommendations made include the following :

(1) Wages of farm workers should be regulated.
(2) A basic rural wage should be paid to all workers in rural industries.
(3) A minimum rate should be fixed for each particular rural industry.
(4) Farming awards should provide for an average week of five and a half days, but Sunday and half-day work should be shared by all workers on the farm, without the payment of overtime rates.

The recital of reasons for recommending the award emphasize the important influence of employees' working conditions on costs. The reasons, summarized are, it would end exploitation of farm labour, it would restrain rises in land values, it would promote efficiency in the case of large farms, it would ensure a better chance of securing labour, it would place Australia on a par with " enlightened agricultural countries in which the efficient agricultural worker is regarded as worthy of his hire ".

Transport Costs.

The discussion of transport facilities is an interesting exposition of the economics of transport. The main theme is that no discriminative freight rates should be introduced favouring distant areas, for each should pay for extra service in proportion to its cost.

Shipping problems are reviewed, and the enormous increase in wartime freight rates is set out. Irrespective of the effect of changes in *ad valorem* charges, e.g. insurance, costs of transport of wheat to British ports rose from 1*s*. 2*d*. to 4*s*. 7*d*. per bushel during the period 1939-1944. The Commission suggests that freights are unlikely to return to pre-war levels, and draws attention to the possibilities of expansion of port facilities in each State.

Some general comments on the railways relating to uniform gauges, the need for new lines, and the advisability of securing greater co-operation in the operation of the lines are made. The old problem of States attempting to protect their financial assets in the railways by restricting road transport is mentioned. Characteristics of air and road transport are discussed. Limitations of the former are set by the estimated cost of 1*s*. per ton mile.

Recommendations refer to the need for co-ordination and direction of transport throughout the Commonwealth ; the railways should be unified, and investigations carried out to analyse transport problems on an economic basis without regard to vested interests.

Taxation, Local Rates, Fire Risks and Other Items.

In the concluding chapter of the Report the Commission discusses the importance to the farmer of taxation, local rates, fire risks and other items. The initial proposition made is that the " modern trend in exacting contributions " is not merely to raise revenue for public administration, but also to equalize incomes, and to adjust

" relationships between economic interests and groups " and to overcome social maladjustments which arise. The limitations of public accounts in indicating the extent to which the burden is borne, and benefits received, by various groups is emphasized by the Commission. The " consideration of rural taxation cannot be divorced from a consideration of the whole national organization—fiscal, economic and administrative—of which it forms part ". The Commission refers, therefore, only to particular points raised in evidence.

The Commission is convinced that in certain areas a longer period than four years should be allowed in which farmers' losses can be carried forward and deducted from income for taxation assessment purposes. It is refreshing to note, even at this late stage, a recommendation which has been acted upon. Losses can now be carried forward for a seven-year period, as recommended by the Commission.

After a discussion of the principles of land taxation, the Commission reviews the effects of the Commonwealth Land Tax, and concludes that :

(*a*) " As a measure designed to break up large estates the tax is unscientific and does not satisfactorily accord with the principles of economic determination of farm size or with planned development and settlement.

(*b*) " As a revenue measure it is inequitable, particularly in its incidence in rural areas."

The outstanding feature of the State land taxes is their lack of uniformity. Some are proportional, others progressive, and the rates vary in different States.

Fire risks are mentioned, and the need to minimize them by control measures on a distinct basis emphasized.

Recommendations also suggest that the Commonwealth and States should institute a financial and economic enquiry with the object of considering a common policy on taxation affecting rural industries. The need for studies of efficiency of protected rural industries is particularly emphasized.

Appendices relating to the details of various matters referred to, including rabbit control, land taxes, wages regulation and mechanization, complete the report.

Some General Comments.

It has been considered desirable in a review of this kind to concentrate on the main theme of the Commission's message. Many contentious issues have been raised, and in order to ensure that the reader obtains an accurate understanding of the Commission's views, discussion has been kept to a minimum. But some things must be said !

The general nature of many recommendations made is a reflection of the limited powers possessed by the Commonwealth in regard to agricultural production. Many of the recommendations refer to the need for co-operation between the States and Commonwealth, the one providing the men, the other the money. Constitutional difficulties may be surmounted but problems of administration are enormous in the implementation of such a policy.

Thoroughness of the survey of determinants of farming efficiency is in accord with the high standard set in all of the Commission's reports so far issued. The discussion is restricted to factors affecting efficiency in so far as they are related to the terms of reference—" the reorganization and rehabilitation of the Australian rural economy during the post-war period ".

The farm management worker, anxious to further his understanding of the problems of individual farms, may be disappointed after the promising start made in the first two chapters. True, later chapters will strengthen faith in his cause, as the Commission expounds the importance of efficiency and its relation to the economy as a whole. But the Commission's terms of reference indicate that their's is not the task of studying individual farms. Instead, they are interested in farms only in

relation to the economy as a whole. They look at things through the low power of their microscope, and leave the high powered work to farm management research investigators.

Even granting this concession, one would have expected a short discussion of farming risks, as such, in this report. Perhaps this has been preserved for inclusion later in relation to land values and land tenure. But the division of this report in such a manner that many factors which are said to be beyond the farmer's control are separated from others within his control, appears to let the farmer, as well as those who advise him, off a little lightly. For the estimation of the financial risks to which farmers are exposed, and particularly their incidence on particular farms, is one of the first steps in the selection of farming as a pursuit, and of a particular farm as the means of earning a livelihood. Farmers may not be able to control such factors, but incidence in the future can be estimated on the basis of past experience and the effect on farm efficiency, productivity and above all on solvency, can be allowed for. If such allowance is not made, then when risks fall, on their own heads be it. Over-optimistic purchasers ignore such risks, while others attempt to recognize their effect and allow for their incidence. For these reasons it is strange that emphasis was not laid upon the relationship between efficiency and farming risks. Risks and their relationship to productivity appear to have been overlooked in the attempt to sort out the maze of interacting variables affecting farm organization and management.

So much for omissions. To discuss possible errors of commission would lead one far afield. Who can remain unmoved by the Commission's views on the respective rôles of various institutions in the educational process? The farm attached to the high school has at least one staunch defender, despite the Commission's views. What should be the limits of State assistance to co-operatives? What of the Agricultural Council and its activities?—even the Commission itself is not unanimous on this point. Where are the defenders of the existing rural wage policy? (Not I, this time, but they can be found!) Is the importance of overhead cash costs adequately recorded? Has the importance of training of the young graduate after entry into the Public Service been overlooked? Whither land tax policy, in view of the Commission's comments on it? These and many more points raised require fuller discussion to do justice to their importance. All who are interested in such matters will acknowledge the excellence of the analysis made and respect the opinions expressed, even though not always agreeing with them. To appreciate the contribution made in this report, it is necessary to read it, rather than this pruned summary designed to indicate its scope.

Response to the recommendations contained in the Report appears to be pitifully slow. However, the Report should convince agriculturalists of the need for attention to the business side of farming, and if it does this, then well may it mimic famous last words:

> "It is a far, far better thing that I do, than I have ever done; it is a far, far better rest that I go to than I have ever known."

D. B. Williams.

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Effect of Molybdenum on the Severity of Toxicity Symptoms in Flax Induced by an Excess of either Manganese, Zinc, Copper, Nickel or Cobalt in the Nutrient Solution.

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It has been recognized in the literature that the presence in the substrate of excessive amounts of any one of the elements manganese, zinc, copper or cobalt will induce iron deficiency symptoms in plants. Many references to iron deficiency due to excessive manganese absorption occur. These are, for the most part, summarized by Somers and Shive,[34] Twyman,[37] and Wallace and Hewitt.[39] Work on zinc-induced iron deficiency has been reviewed recently by Wallace and Hewitt[39] and Millikan.[31] The effect of excess copper in causing iron chlorosis in plants has been described by Willis and Piland,[46] Chapman *et al.*,[13] Liebig *et al.*[29] and Wallace and Hewitt,[39] while a similar effect due to excess cobalt has been recorded by Somers and Shive.[34] Brenchley[9] produced symptoms apparently identical with those of iron deficiency in water cultures with an excess of either cobalt or nickel. Chlorosis in the younger tissues of plants induced by nickel toxicity has also been described by Haselhoff[21] and Cotton.[15]

A study has been made of the effects on the severity of similar toxicity symptoms in flax, caused by an excess of either manganese, zinc, copper, nickel or cobalt respectively, of supplying additional molybdenum to the solutions. Experiments have been conducted at all seasons of the year, both indoors and out of doors.

Method.

The nutrient solution used was that of Arnon,[5] and included the A4 and B7 solutions of trace elements. An iron solution containing 0·5 per cent. $FeSO_4.7H_2O$ and 0·4 per cent. tartaric acid was added twice weekly at the rate of 0·6 ml. per litre of culture solution. The flax varieties used were Liral Crown and Concurrent and the seedlings were germinated in washed sand and transferred as soon as possible after emergence to the water cultures. Two litre pyrex glass beakers were used and twelve seedlings were grown in each. The excess mineral treatments were applied immediately after setting up the cultures, and the experiments were normally concluded from 8-10 weeks later.

Four separate experiments have been made with copper, zinc and manganese, and three with cobalt and nickel.

The following are details of the heavy metal treatments applied in excess of the amount of the particular elements in the normal solution :

Copper (as $CuSO_4.5H_2O$) : 0·05, 0·1, 0·5, 1 and 2 parts per million respectively.
Zinc (as $ZnSO_4.7H_2O$) : 2·5, 5, 10, 20 and 50 parts per million respectively.
Manganese (as $MnSO_4.4H_2O$) : 10, 20, 25, 50, 100 and 150 parts per million respectively.
Cobalt (as $Co(NO_3)_2.6H_2O$) : 0·5, 1, 2 and 5 parts per million respectively.
Nickel (as $NiSO_4.7H_2O$) : 0·5, 1, 2 and 5 parts per million respectively.

At each of the above concentrations of heavy metals molybdenum (as ammonium molybdate) was added at the following levels : 0·1, 0·5, 1, 2, 5 and 10 parts per million. In some experiments with manganese and zinc, concentrations

of 25, 50 and 100 parts per million of molybdenum were also included. In addition, the effects of excess molybdenum at all the above concentrations were studied without the addition of an excess of any heavy metal.

Results.

A detailed description of the toxic effects of the heavy metals on the flax plant, which were produced in these and other water culture experiments, will be given elsewhere. The point of particular interest here is that individual excesses of copper, zinc, manganese, cobalt or nickel respectively, were found to produce symptoms of chlorosis, followed in many cases by necrosis of the top of the plant, which appeared to be identical with those of iron deficiency. By way of confirmation it was found that the appearance of this chlorosis and necrosis could be entirely prevented by supplying additional iron to the culture solution. However, even with the alleviation of iron deficiency symptoms by this additional iron supply other toxic effects such as marked stunting of the roots and aerial parts of the plants, and characteristic necrotic symptoms on the lower leaves (the latter not typical of iron deficiency) occurred.

For example, a characteristic type of lower leaf necrosis occurred consistently in the excess manganese cultures (particularly at concentrations of 25 parts per million or more) with or without the presence of iron deficiency symptoms in the upper leaves, the latter depending upon the amount of iron supplied to the solution. Identical symptoms of lower leaf necrosis have also been produced in highly acid soils by heavy applications of manganese sulphate in unpublished experiments by the writer.

The occurrence of this lower leaf necrosis does not support the contention of Somers and Shive[34] that pathological symptoms resulting from excess manganese are identical with those of iron deficiency symptoms and vice versa. Other points of divergence occurred, which will be described elsewhere.

Manganese was found to be much less toxic to flax root development than zinc, copper, nickel or cobalt. At the highest concentrations of these latter four elements aerial growth was also seriously reduced.

Unlike the toxic effects of the trace elements outlined above, excess molybdenum applied to the nutrient solution by itself did not produce iron deficiency chlorosis in flax. At increasing concentrations of molybdenum (10 to 100 parts per million) growth of roots and tops was progressively reduced and a golden yellow to orange discoloration occurred in the roots and to a lesser extent in the lower leaves. The leaves tended to be darker green than normal. At the lower concentrations of molybdenum (5 parts per million or less) an initial orange discoloration and dwarfing of the roots occurred, but growth later became much less stunted. Warrington[42, 43] has also described a golden-yellow or reddish-yellow colour in tomato, potato and lettuce plants respectively when grown in solutions containing high concentrations of molybdenum. These colour reactions were found to be associated with the presence of yellow globules of a tannin-molybdenum compound in the tissues. Tissues of molybdenum treated plants containing anthocyanin also showed large numbers of blue-granular accumulations which were apparently of an anthocyanin-molybdenum nature. The presence of tannin has also been demonstrated in the golden-yellow flax roots produced in the excess molybdenum solutions at Burnley.

It was found that the addition of molybdenum to solutions containing an excess of either manganese, zinc, copper, nickel or cobalt respectively, at the concentrations listed above, resulted in marked reductions in the severity of iron deficiency symptoms in flax grown therein, compared with the severity of symptoms which occurred in the presence of the same concentration of the heavy metal alone (Fig. 1). It was usual in the presence of the higher concentrations of the heavy metals alone, for the tops of the plants finally to become necrotic due to severe iron deficiency, whereas the addition of molybdenum to solutions containing the same concentrations of these heavy metals prevented this necrosis, although chlorosis often occurred (Fig. 2).

The reduction in the severity of iron deficiency symptoms increased with increasing molybdenum concentration, the most effective range being from 5 to 25 parts per million. Concentrations of 0·5 and 1 part per million of molybdenum were relatively ineffective in this regard.

Figure 1.
Effect of molybdenum on the severity of manganese toxicity symptoms in flax. Plants receiving excess manganese alone showed severe iron deficiency chlorosis followed by necrosis of the younger tissues. These symptoms were absent in plants receiving excess manganese plus molybdenum.

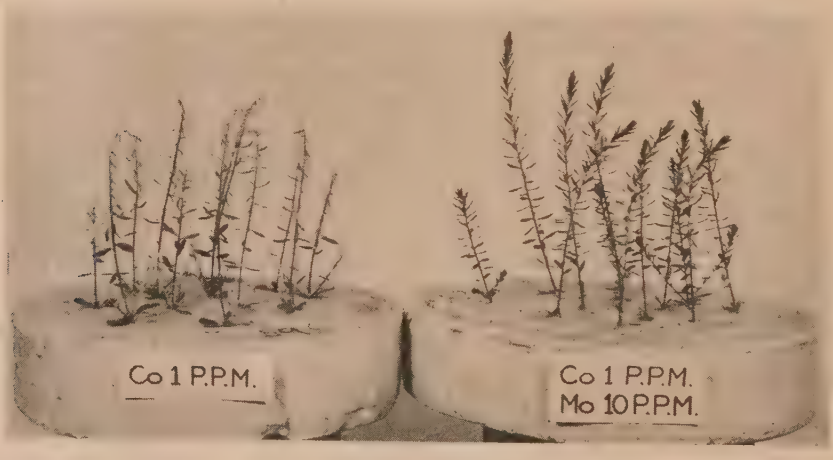

Figure 2.
Effect of molybdenum in preventing iron deficiency necrosis of the tops of flax plants, induced by excess cobalt. Molybdenum had a similar effect in other experiments with excess manganese, zinc, copper or nickel respectively.

At the higher concentrations of the heavy metals, the effects of applications of molybdenum and iron respectively were similar in that neither alleviated other symptoms of toxicity such as severe dwarfing of roots and aerial parts, except that dwarfing resulted from iron deficiency necrosis of the tops of the plants (Fig. 1). However, with excess manganese (25 to 150 parts per million), the addition of

molybdenum (5, 10 or 25 parts per million respectively) also retarded the date of appearance, and reduced the severity of lower leaf necrosis, which is a characteristic symptom of manganese toxicity (Fig. 3). This important effect of molybdenum has been confirmed in several unpublished experiments by the writer using strongly acid soils treated with heavy dressings of manganese sulphate with and without molybdenum.

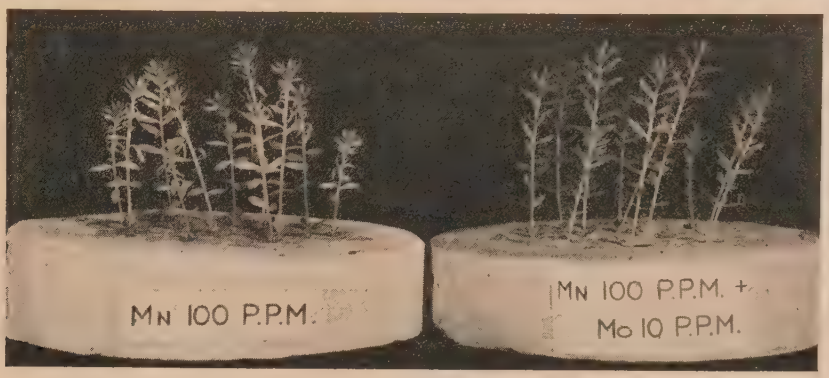

Figure 3.
Showing the prevention of manganese-induced lower leaf necrosis in flax as the result of supplying additional molybdenum. The incidence of this symptom was unrelated to the iron status of the plants.

Discussion.

The actual means by which the so-called heavy metals manganese, zinc, copper, nickel and cobalt induce iron deficiency in plants is still obscure. It has been shown by Rippel,[33] Chapman[12] and Millikan[31] that plants manifesting symptoms of iron deficiency chlorosis associated with an excess of manganese or zinc as the case may be, may actually contain the same or a higher content of iron than normal plants, indicating that not iron assimilation, but its action in the tissues, is unfavourably affected by the presence of an excess of the heavy metal. Somers and Shive[34] suggest that this unfavourable effect is due to the heavy metal (manganese or cobalt) catalysing the oxidation of the physiologically active ferrous iron to the inactive ferric form, with the probable formation of an insoluble ferric-phosphate-organic complex. However, Somer and Shive's view of the mechanism of the oxidation of ferrous iron to the ferric state has been shown by Leeper[27] to be fallacious. On the other hand, Kriel (cited by Bennett[9]) suggests that manganese does not interfere with iron utilization in the leaf but produces chlorosis by depressing the absorption of iron. The ratio of manganese to iron in tissue had no relation to the chlorosis produced.

There is apparently little information available to date on relationships between molybdenum and other elements in the plant. Mitchell *et al.*[32] and Watson[44] found that the application of cobalt to the soil resulted in an increased uptake of molybdenum in the herbage growing in the soil so treated particularly when the soil was rich in molybdenum, i.e. an increase in the cobalt concentration in the plants apparently increased their molybdenum requirement. A relationship has also been observed between molybdenum and copper in animals by Ferguson *et al.*[18] in their work on " teart " disease of sheep. This disease, which results from the absorption of excessive amounts of molybdenum in the herbage, was cured by dosing the animals with copper.

Molybdenum toxicity or " teartness " occurs on neutral and alkaline soils, and molybdenum availability decreases in passing from alkaline to acid soil reaction values.[28, 36] Thus the effect of soil reaction on molybdenum availability is the

opposite of its effect on the availability of manganese, zinc, copper and iron as the bulk of the evidence in the literature indicates that increasing acidity increases the availability of these elements in the soil, although it is probable that in strongly acid soils it is usually the presence of excessive amounts of available manganese compounds which play an important rôle as a growth inhibiting factor.[19, 20, 40] However, plants growing on such soils may also be suffering from a deficiency of molybdenum. Liming of molybdenum responsive soils has been shown to improve growth. This beneficial effect of lime has been attributed to an increase in the availability of molybdenum following a rise in the pH of the soil, but concomitantly with such an improvement in the molybdenum status in the soil there would be a decrease in the availability of manganese and other elements.

Thus the relative importance of molybdenum deficiency and manganese toxicity as growth-inhibiting factors on strongly acid soils cannot be ignored, and would be dependant upon the species of plant involved and its normal requirement of these elements. The existence of a close relationship in the plant between molybdenum and the so-called heavy metals including manganese as demonstrated in the above experiments would be highly important under such acid soil conditions.

Anderson and Thomas[4] have summarized the plant responses to molybdenum which have been reported by a number of workers using either purified water cultures or certain acid soils. The plant species involved have included tomatoes, oats, lettuce, white mustard, myrobolan plum seedlings, cauliflower and legumes. In general, it has been found that all the various types of molybdenum-deficient plants show a slight chlorosis with a necrosis of the margins of the lower leaves. With legumes, this chlorosis has been attributed to nitrogen deficiency due to faulty symbiotic nitrogen fixation. However, there is a general similarity between molybdenum deficiency and manganese toxicity symptoms in plants. In water cultures at Burnley, flax growing with an excess of manganese and a moderate iron supply showed only a slight chlorosis (due to iron deficiency) and a necrosis of the lower leaves from the margins which was not typical of iron deficiency. The report of Davies[17] that "whiptail" disease of cauliflowers may be prevented by molybdenum is also of interest here as manganese toxicity symptoms in cauliflower appear to be very similar, if not identical, to those of "whiptail" disease.[38, 40] Also in unpublished pot experiments using flax grown in strongly acid soils treated with heavy dressings of manganese sulphate, the writer found that small applications of molybdenum resulted in a deeper green colour, and prevented serious manganese-induced lower leaf necrosis.

Australian workers, of whom the most recent are Anderson and Thomas[4] and Anderson and Oertel [3] have found that grasses may not respond to molybdenum, whereas clovers growing on the same soil do. This difference in responsiveness to molybdenum is probably due to a difference in the normal molybdenum requirements of these two types of plants, as legumes have been shown to have a much higher content of molybdenum than grasses (Lewis [28] Ter Meulen (cited by Hoagland[22])).

With regard to the relative manganese requirements of plants grown on the same soils, McHargue[30] concludes that different species show a considerable range in manganese content. Leguminous plants usually contain the least amount of manganese and grasses the greatest amount. It is known that clovers will make satisfactory growth on alkaline soils on which cereals show severe symptoms of manganese deficiency. Grasses may also be as susceptible to manganese deficiency as cereals.[41] On an acid soil Fried and Peech[19] showed that a heavy application of manganese caused severe injury to lucerne, but had no apparent effect on barley and perennial rye grass. Different legumes also manifest different manganese requirements. Thus of a number of legumes which they studied, Jones and Bullis[24] found that lucerne had the lowest and alsike clover the highest contents of manganese. Previously Crochetelle[16] had shown that high concentrations of manganese sulphate had a greater deleterious effect on the germination of clover than on that of cereals.

From the above it would appear that plants with a high requirement

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for molybdenum may have a low requirement for manganese (and possibly other heavy metals). On highly acid soils, therefore, such plants would be likely to be injured by the presence of excessive amounts of available manganese in the soil, unless supplied with adequate molybdenum.

The results of Anderson and Oertel[3] could be explained on the basis of the manganese-molybdenum antagonism. They showed that in the presence of applied molybdenum, yields of lucerne were significantly higher with increased lime or superphosphate, indicating that some factor other than a simple molybdenum deficiency was operating. Many plants not treated with lime were yellow at the first harvest. The intensity of the chlorosis was also increased by raising the level of phosphate application. It has been shown in the Burnley water cultures that flax plants grown in the presence of excess manganese were still dwarfed even when excess molybdenum was applied (Fig. 1). In molybdenum responsive soils this dwarfing due to excess manganese in the presence of applied molybdenum could be alleviated by raising the soil pH with lime. Thus for maximum yields on molybdenum-responsive soils a dressing of lime plus molybdenum has been recommended.[1, 2, 17]

The application of manganese in an amount only slightly in excess of that found in acid soils was shown by Fried and Peech[24] virtually to prevent the growth of lucerne which, as shown above, has a low requirement for this element. Liming reduced the manganese content of the plants. Further, the writer has found that an increased phosphate supply will increase the intensity of manganese-induced iron deficiency chlorosis. Kapp[25] and Chandler and Scarseth[14] working with rice and lucerne respectively have reported that an increase in the phosphate content of the plants decreased the iron content of the leaves and under certain conditions induced iron deficiency chlorosis.

It is known that molybdenum functions in the reduction processes of plants. The presence of molybdenum results in a large increase in nitrogen fixation by *Azotobacter*. From this Horner *et al.*[23] and Burema and Wieringa[10] concluded that molybdenum acts as a reducing agent in the assimilation of atmospheric nitrogen by *Azotobacter*. Similarly, Steinberg[36] found that when nitrate was the source of nitrogen, the requirement of *Aspergillus niger* for molybdenum was greater than when ammonium N or organic N was the source. He suggested that molybdenum was essential for the activation of the nitrate reductase in the process whereby nitrates are reduced to ammonium for the synthesis of amino acids and proteins.

In this regard also, Arnon[6] has demonstrated that barley plants grown in a nutrient solution supplied with nitrate nitrogen had a greater requirement for manganese than did plants which received ammonium as the sole source of nitrogen. Similarly, Burström[11] has shown that a function of manganese in plants is to catalyse the reduction of nitrates to amino compounds. In the absence of manganese this reduction does not take place, with the result that manganese-deficient plants are extremely high in nitrates.[26, 45]

While molybdenum and manganese may have somewhat similar rôles in the reduction of nitrates in plants, they evidently have opposite functions in respect to iron utilization. The results of the water culture experiments herein described indicate that the available molybdenum supply is an important factor in reducing the injury to the plant resulting from the uptake of excessive amounts of manganese, copper, zinc, nickel or cobalt. It is concluded that an essential function of molybdenum is intimately associated with the regulation of the deleterious effects of the above elements on the physiological availability of iron to the plant.

Summary.

The addition of molybdenum to solutions containing an excess of either manganese, zinc, copper, nickel or cobalt respectively, resulted in decreases in the severity of iron deficiency symptoms which normally occurred when flax was grown in solutions containing the same concentrations of any of these elements, but without

molybdenum. The efficacy of molybdenum in this regard increased with increasing concentration up to 25 parts per million. However, concentrations of 0·5 to 2 parts per million of molybdenum had little effect on the severity of iron deficiency symptoms at the concentrations of heavy metals used.

At the higher concentrations of manganese, zinc, copper, nickel or cobalt used, the effects of application of molybdenum and iron were similar in that neither alleviated other symptoms of toxicity such as severe dwarfing of roots and aerial parts, except that dwarfing of the tops resulting from iron deficiency necrosis.

Molybdenum 5, 10 or 25 parts per million also retarded the date of appearance and reduced the severity of lower leaf necrosis which is another characteristic symptom of the presence of excess manganese (25 to 100 parts per million) in the nutrient solution. This symptom is unrelated to the iron status of the plant.

It is concluded that an essential function of molybdenum is intimately associated with the regulation of the deleterious effect of manganese, zinc, copper, nickel or cobalt on the physiological availability of iron to the plant.

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Technical Notes

MOLYBDENUM IN RELATION TO WHIPTAIL OF CAULIFLOWER.

The whiptail disease of cauliflower (*Brassica oleracea* var. *botrytis* L.) has been known for many years in New South Wales and in certain districts is responsible for considerable losses in commercial crops. Experiments carried out first by Clayton[1] and Wessels[5] in the United States, and later by Magee[3] in this country, showed that the addition of lime to the soil would largely control this disease. Subsequent experiments and observations in this State* indicated, however, that whilst there was usually good correlation between whiptail and soil acidity, the occurrence of this disease could not be ascribed wholly to acid soils.

As a result of the findings in New Zealand of Mitchell,[4] following earlier work in the same country by Davies,[2] that the application of ammonium molybdate at rates of 1, 5 and 20 lb. per acre to the soil prior to planting, prevented the development of whiptail, it was decided to test the value of molybdenum in controlling whiptail under Australian conditions. During 1947 an experiment to determine the effect of sodium molybdate was carried out at Cornwallis, Windsor, in which district whiptail is often responsible for serious losses in commercial crops, particularly where early maturing varieties are planted on acid soil and heavily fertilized with nitrogenous materials such as sulphate of ammonia.

Methods.

The experiment was laid out in the form of a 4×4 factorial, duplicated. Four levels of sodium molybdate were used—0, $\frac{1}{4}$, 1 and 4 lb. per acre—and four levels of soil acidity were provided by applying 500 lb. per acre of sulphur, no sulphur or dolomite, 1 ton per acre of dolomite and 2 tons per acre of dolomite. This provided 32 plots, each of which was 11 yards by 11 yards ($\frac{1}{4}$ square chain).

Land on which whiptail had previously occurred and where the pH of the soil ranged from 6·6 to 7·0 was used. The sulphur, dolomite and sodium molybdate were applied to the plots by hand on 17th February, 1947, the sodium molybdate being dissolved in water and watered on by watering can. The plants (variety Nugget, seed sown in second week of January) were transplanted from the seed beds to these plots during the last week of February and first week of March, the planting out process being interrupted by heavy falls of rain. The plants were spaced one yard apart, giving 121 plants per plot. After planting out, heavy rains repeatedly flooded the experimental plots, resulting in the death of a considerable number of plants, especially in one section of the plots.

Results.

Severe whiptail occurred only in the plots treated with sulphur and either no sodium molybdate or $\frac{1}{4}$ lb. of sodium molybdate per acre. Where sulphur was used and no sodium molybdate applied, 22 out of a total of 50 surviving plants showed severe whiptail, whilst another 25 plants were lightly to moderately affected. Where sulphur—$\frac{1}{4}$ lb. sodium molybdate was used, 15 out of a total of 229 surviving plants were severely affected and an additional 90 plants were lightly to moderately affected.

In the remaining 28 plots seven plants were lightly to moderately affected. Three of these were in the sulphur-1 lb. sodium molybdate plots (out of 110 surviving plants), three in the control plots with no sulphur, dolomite or molybdenum (out of 180 surviving plants) and one in a $\frac{1}{4}$ lb. sodium molybdate only plot (out of 190 surviving plants).

No trace of whiptail occurred in any of the plots to which dolomite or sodium molybdate at the heaviest rate was applied, or in the two plots which had received one pound of sodium molybdate per acre and no sulphur or dolomite.

* Carried out by C. J. P. Magee and W. Whan (unpublished).

At the completion of the experiment in July, 1947, pH readings of the soil in the various plots were made. Plots which had received sulphur had an average pH of 6·1, those which had received no sulphur or dolomite 6·8, those which had received dolomite at one ton per acre 7·2, and those which had received dolomite at two tons per acre 7·7.

Conclusion.

It would appear that under the conditions of the experiment one pound of sodium molybdate per acre was adequate to prevent all except a trace of whiptail on the land which had been treated with sulphur, whereas $\frac{1}{4}$ lb. of sodium molybdate per acre was inadequate. The results obtained confirm the earlier work[1, 3, 5] regarding whiptail and soil acidity, and also that of Mitchell[4] in New Zealand concerning molybdenum. It would appear that the relationship of soil acidity to whiptail of cauliflowers, as suggested by Davies,[2] depends on the fact that the availability of molybdenum decreases as soil acidity increases.

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TOMATO BIG BUD.

The virus disease big bud has been reported in tomatoes and other crops in various parts of the world. It occurs sporadically in most tomato areas in Australia, and only occasionally causes severe losses. It has been shown by Hill[1] to have a very wide host range.

With a view to investigating the resistance of tomato varieties to this disease, a survey of the incidence of big bud infection in tomato plots at the Griffith Research Station and on thirty farms in the Griffith and Yenda districts of the Murrumbidgee Irrigation Area was carried out in April, 1945, and again in April, 1946. In the Research Station plots, 200 plants of each variety were examined both years. The farm survey entailed the observation of 2,500 plants of each variety on each of the two occasions. The results are summarised in Table 1.

It will be seen from the table that the amount of big bud recorded in either year was not high. It is apparent that, with the exception of San Marzano and Stemless Pennred, the incidence of infection among varieties was not the same on the two occasions. The percentage of big bud in Pearson on farms compared with that for the plots is different in both years, although for Tatura Dwarf Globe such differences are not so marked. Riverside, which had 4 per cent. of big bud in 1945, had none in 1946. It is concluded from the results obtained that the differences observed are due to the random nature of big bud infection, and not to any inherent differences in the susceptibility of the various varieties.

A search for inherent physiological resistance to this disease among lines of *Lycopersicon peruvianum*, *L. pimpinellifolium* and *L. hirsutum* proved fruitless. These three species developed the disease naturally in field plots at the Dickson Experiment Station, Canberra. After grafting with big bud scions in the green-

house, all three species gave reactions similar to those obtained under the same conditions with the various varieties of *L. esculentum.* Figure 1 shows the effect of big bud grafting in *L. peruvianum.*

TABLE 1.
Occurrence of Big Bud among Tomato Varieties.

Variety.	Location.	1945 Average Percentage Big Bud.	1946 Average Percentage Big Bud.
Adelaide Dwarf Red	Plots.	—	2·8
Break o' Day	,,	—	2·6
Garden State	,,	—	2·9
Grosse Lisse	,,	1·8	0·9
Indiana Baltimore	,,	0·9	2·7
Morse's Special Early	,,	—	6·6
Pearson	Farms.	0·5	1·9
	Plots.	1·8	2·7
Red Cloud	,,	—	0·8
Riverside	,,	4·0	0·0
San Marzano	Farms.	1·1	1·4
Stemless Pennred	Plots.	5·4	5·5
Tatura Dwarf Globe	Farms.	2·4	1·6
	Plots.	1·8	1·6

Figure 1.
Lycopersicon peruvianum Inoculated with Tomato Big Bud by Grafting.

The lack of variation in the physiological response to big bud in the material examined would seem to indicate that resistant lines for use in the development of big bud-resistant varieties will be difficult to find. At present the use of D.D.T.

or similar sprays timed to coincide with the flights of the leaf hopper vector offers better chances of control where big bud becomes a limiting factor in tomato production.

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RESISTANCE IN THE POTATO TO THE SPOTTED WILT VIRUS.

In the 1945 and 1946 seasons spotted wilt was a serious disease of potato crops in Southern Tableland districts of New South Wales,[1] and was more prevalent in Victorian[2] crops. It was also troublesome in potato plots at the Dickson Experiment Station of the C.S.I.R. in Canberra, where there appeared to be a close relationship between the density of the thrips vector and the incidence of spotted wilt. In 1943 and 1944, when spotted wilt was not observed, only small numbers of thrips were present, and successful field crosses in potatoes were made. In 1945 and 1946, when spotted wilt appeared, thrips were abundant, indeed so numerous that all field crosses attempted were unsuccessful, due to the destruction of the potato pollen by these insects.

In 1945 the early planted varietal and hybrid section of potato plots at Dickson was free from spotted wilt infections, but in 1946 ,when the early section was planted in October, a month later than in the previous year, there was a widespread infection. About 20 per cent. of the plants among each of the leading Australian varieties, Carman, Up to Date and Bismark, were infected. Brownell and Delaware, two other important varieties, were not available for observation. Among newer varieties Sebago was equally as susceptible as Up to Date, but Katahdin only had 0·5 per cent. infected plants.

Fifty varieties were inoculated by hand in greenhouse tests and Up to Date, New Zealand Pink Eye and Sebago proved easy to infect. Figure 1 illustrates the type of systemic infection secured in Sebago. Katahdin and Sequoia, on the other hand, although tested several times, have always given a localised reaction (see Figure 2). Most of the other varieties, including the field-susceptible varieties Carman and Bismark, have, in single tests, reacted similarly. The technique used in the greenhouse did not define clearly the resistance or susceptibility of varieties.

A widespread infection of spotted wilt in the field was recorded throughout the potato hybrid plots in the 1946 season. Most hybrid lines were represented by twelve plants, and where infection occurred the percentages of plants infected varied from 8 to 100 per cent., the average being approximately 20 per cent. Up to Date check plots of twelve plants distributed at random in each group of twelve hybrid lines contained, with two exceptions, one or more infected plants. Over all the Up to Date check plots an average of 20 per cent. of the plants had spotted wilt. For the purpose of the results summarised in Table 1 a hybrid line was considered susceptible if it had one or more plants in it diseased. There may be a difference between a line with only one plant affected compared with a line in which twelve plants had spotted wilt, but it is assumed that lines which show any plant giving typical spotted wilt symptoms in the field are not inherently resistant or immune. It is also possible that a few lines which showed no infected plants are susceptible types.

In Table 1 each type of progeny is a group of three different crosses with the same basic parentage. With one exception among Carman, Bismark and Up to Date crosses respectively, all types of progeny are from crosses between the variety stated and one of the six Snowflake cross lines at the bottom of the column. The Snowflake cross lines are double hybrids including the varieties Snowflake and Katahdin. The single crosses with Carman, Bismark and Up to Date which did not include these Snowflake-Katahdin lines were developed from crosses with Brown's River-Katahdin

Figure 1.
Sebago potato plants systematically infected with spotted wilt.

Figure 2.
Sequoia potato plants showing localised reaction on infection with spotted wilt.
(Both photos. by T. Pickard.)

hybrids. The lines of the Snowflake cross listed are highly resistant or field immune to the spotted wilt virus, so that the various types of progeny can be regarded as having been developed from one resistant parent. Results largely reflect the resistance of the other parent such as Carman and other well-known varieties. The susceptibility of the varieties Bismark, New Zealand Pink Eye, Carman, and Up to Date have been established, so the relatively high percentages of susceptible lines shown in their progenies are understandable. Indications from the table are that Brownell, Brown's River, Snowflake and Epicure may carry a high proportion of factors for resistance.

The important feature of Table 1 is the high percentages of lines without spotted wilt in the various progenies. Within the highly susceptible Bismark inbred lines, almost half had no spotted wilt in the field. Even allowing for disease escape in a proportion of the non-susceptible hybrids, the percentage which appears resistant is

TABLE 1.
Showing the Percentages of Lines of Various Hybrid Progenies Affected with Spotted Wilt in the Field in the 1946 Season.

Type of Progeny.	Percentage of the Lines Susceptible to Spotted Wilt.	Number of Lines Under Test.
Inbred Bismark	55	148
New Zealand Pink Eye Crosses ..	30	62
Carman Crosses	25	64
Bismark Crosses	21	89
41956 Crosses	20	61
Mohawk Cross	20	21
Up to Date Crosses	18	68
Brownell Crosses	13	55
Brown's River Crosses	8	75
Epicure Cross	6	68
Snowflake Cross	0	6

high. It is apparent that spotted wilt resistance is likely to be inherited in at least 50-70 per cent. of hybrid progeny, even in potato crosses involving one susceptible parent.

The evidence presented suggests that the potato is naturally fairly resistant to spotted wilt. Susceptible varieties like Up to Date are resistant to systemic invasion of the disease if they are past the flowering stage when exposed to the risk of infection resulting from a high thrips population. Early planted plots of susceptible varieties at Dickson Experiment Station have always missed the disease. Even when the cracked and distorted tubers from severely infected Up to Date plants are planted only a 31 per cent. transmission of the disease is obtained.[3] These facts, together with the evidence that resistance to spotted wilt in the susceptible pre-flowering stage can be obtained by breeding, leads to the conclusion that this disease will not menace the Australian potato industry.

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The Australian Institute of Agricultural Science

ELEVENTH GENERAL MEETING.

The eleventh general meeting of the Institute was held in Perth on 18th and 19th August at the invitation of the Western Australian Branch. This was the first general meeting of the Institute in Western Australia, and visiting members appreciated the very satisfactory arrangements made by the local Branch for the conduct of the meeting. At the opening session the President (Mr. G. de Vahl Davis) delivered a stimulating address on Institute affairs and the responsibilities of Institute members to the community. The President's remarks with reference to the work of the Council during the past year were amplified in reports from the Honorary General Secretary (Dr. F. T. Bowman) and, by deputy, from the Honorary General Treasurer.

A résumé of the report by the Honorary General Secretary, which earned warm commendation, is published below in accordance with a resolution from the meeting.

During this session it was resolved that a telegram on the question of the interchange of personnel be sent to the Prime Minister and State Premiers then meeting in Canberra. The matter is dealt with more fully under Current Notes and News.

The second session, devoted to Institute policy, organisation and finance, was presided over by Professor H. C. Trumble as delegate for the South Australian Branch. The question of how Institute policy can best be formulated and issues so crystallised that delegates from Branches attending general meetings can act most helpfully on behalf of those they represent provoked much discussion. It was agreed that the machinery necessary for such purposes existed, but a responsibility lay with Branches to initiate questions of policy well before a general meeting so that all other Branches could consider the matter, crystallise their views on the issue raised, and be prepared to act decisively in voting at general meetings.

The meeting then went on to consider a notice of motion from some Victorian Branch members to repeal, alter or amend the Articles of Association in so far as they apply to membership. The motion, in the terms proposed, was lost, but it was resolved that Council be requested to appoint a committee to examine the Memorandum and Articles of Association with a view to proposing amendments with special attention to the admission of members and to the powers and authority of the general meeting in relation to Council. (Article 31.) The question of the time and place of general meetings was also discussed and it was resolved to support the general principle of holding meetings in conjunction with meetings of A.N.Z.A.A.S. The need for additional funds for carrying on the Institute's work was also stressed and Council was asked to explore all ways of improving the financial position of the Institute. Relevant to this need were further resolutions carried at a subsequent session devoted to the question of Institute's publication and publicity. At this session, presided over by Mr. H. R. Powell (W.A. Branch President), the following resolutions were accepted :

Resolution 8. " Having in mind the final decision of C.S.I.R. in the matter of publishing a Journal of Agricultural Research, this meeting suggests that the A.I.A.S. Journal can be modified so as to provide a satisfactory medium for the publication of technical papers and accordingly resolves that financial support be sought from appropriate authorities so as to enable such development to be carried into effect."

Resolution 9. " That Council be asked to explore the possibilities of publishing, under the guidance of the Publications Committee, a magazine of " Progress in Australian Agricultural Science ", with the objective of making available in a general sense authoritative material concerning the application of the findings of science to Australian agriculture."

Questions of salary and status and the interchange of scientific personnel occupied the second half of the third session, which was presided over by Mr. A. C. T. Hewitt (Victorian Branch President).

On the question of salaries and status it was resolved :

(i) That each Branch appoint a committee to draw up a schedule of salaries to cover both the basic, incremental range and also higher classifications of all services in which members of the Branch may be employed.

(ii) That such a schedule be prepared only after the widest possible consultation with the members in the various services concerned.

The question of interchange of personnel is referred to in a report elsewhere in this issue (page 161). Council was also asked to :

(1) Examine the resolutions of the Commonwealth Scientific Official Conference, London, 1946, in relation to improving facilities for the interchange of trained agricultural scientists and take all possible steps to secure their implementation.

(2) Conduct a survey of the facilities existing in the Commonwealth of Australia (particularly in the way of scholarships and studentships) for agricultural workers to proceed overseas and gain additional experience with overseas workers.

(3) Initiate action designed to obtain travelling concessions and subsistence allowances for agricultural scientists who desire, during leave periods, to visit approved institutions within the Commonwealth of Australia.

The proceedings of the meeting terminated with a successful dinner tendered by the Western Australian Branch on the evening of 19th August to visiting delegates. Besides interstate

visitors and Sir Theodore Rigg from New Zealand, the dinner was attended by the Assistant Minister of Agriculture in Western Australia (Mr. Wood), the Vice-Chancellor of the University of Western Australia (Dr. G. A. Currie) and other prominent persons in Western Australia. In his remarks Mr. Wood said that agricultural scientists should not remain, as they are in this State and in other parts of Australia among the lowest paid professional men. Under present conditions, Mr. Wood continued, young people tended to follow other professions, and of those who entered agricultural science many were attracted to other States or to the Commonwealth service. "I do not control the finances of the State", he said, "but I do promise you that I will continue to press for better conditions for agricultural scientists so that our department will be able to hold its outstanding workers and attract the best brains of the rising generation." Sir Theodore Rigg, Professors E. J. Underwood and H. C. Trumble, Dr. G. A. Currie and several others also spoke.

Report from Council to the Eleventh General Meeting.

The résumé which follows, prepared by the Honorary General Secretary (Dr. F. T. Bowman), covers action taken by Council pursuant to the resolutions of the ninth and tenth general meetings.

The creation of an *Award of Merit* was investigated by a Council sub-committee (Dr. C. Barnard convener). The report was circulated to Branches and a collation of views revealed agreement on the creation of an award for agricultural research and other agricultural work during the previous five years.

Council has been giving very careful consideration to improving the *financial position of the Institute* owing to the fact that expenditure has exceeded income for the last three years. Council expenses have definitely increased because of the need for clerical assistance. After examining all possibilities Council found that one major item held the possibilities of being made partially self-supporting and therefore recommended that advertising be reintroduced into the Journal.

Co-ordination of Research has been recognised as a definite need in New South Wales. The Branch was instrumental in achieving the creation of a Research Co-ordination Committee, under the chairmanship of the Chairman of the Public Service Board, and having a representative of all instrumentalities carrying out research in the State, such as the Departments of Agriculture and Conservation, C.S.I.R., and the University. This achievement was reported in detail to other Branches, who have been requested to examine the position in their States.

On *salary and status*, a Council sub-committee (Mr. Butler and Miss Wrigley) has prepared a survey of the present salaries in all services throughout Australia. As the result of discrepancies revealed, the Institute has now sought the advice of an Industrial Advocate to ascertain what action might be taken to overcome anomalies in salaries for corresponding positions and to improve salary conditions for members.

On *interchange of personnel*, a Council sub-committee (Mr. C. M. Donald convener) has prepared an excellent report which has been circulated to Branches. Recently the report was forwarded to the Prime Minister and by the Branches to their Premiers, in time for consideration before this question is discussed at the 1947 Premiers' Conference. The report is published on p. 161 of this issue.

The Institute has pressed with the C.S.I.R. the need for establishing an *Australian Journal of Agricultural Research*. This appeared to be on the point of establishment when a wider scheme was envisaged by C.S.I.R.—the publication of an Australian Journal of Research, divided into two series, one on the physical and another on the biological sciences. The Institute is endeavouring with C.S.I.R. to secure the establishment of a third series in this projected Journal, to be specifically devoted to agricultural science.

On the sponsoring of *Scientific Conferences*, the Institute can justly claim the credit of sponsoring the highly successful Conference of Cereal Breeders and Geneticists, Adelaide, 1946. The Institute has now defined its policy as one of making representations and/or submitting plans to administrative bodies likely to be concerned in financing such conferences.

MEETINGS OF COUNCIL.

Council met on 5th August in Sydney and on 18th August in Perth immediately prior to the eleventh general meeting of the Institute. Much of the discussion at these two meetings dealt with items considered at the eleventh general meeting and referred to under that subject on page 193.

Membership.—The following were admitted to membership at the meeting on 5th August:—As corporate members: Messrs. C. J. King, T. H. Lemerle, Dr. P. R. McMahon, Messrs. S. N. Old, S. M. Paton (N.S.W.), P. F. Butler, R. W. Jessup, G. M. E. Mayo (S.A.) F. Skaller (Vic.); as student members: Messrs. K. Baumgartner, D. G. Cameron, A. J. Crawford, F. S. Feagan, F. J. Gardner, W. J. C. Hudson, R. I. Johnson, W. H. Litchfield, E. J. Martin, N. H. Monteith, J. A. Morris, J. T. Mullet, M. Mullin, Miss M. Murphy, Messrs. T. Sorenson, J. Strang (N.S.W.), F. M. Hilton, T. D. Kentish, M. R. Till (S.A.).

Honorary membership during the term of their travelling scholarships was conferred on Mr. R. L. Reid (N.S.W.), Mr. L. C. Birch (S.A.), Miss M. P. Thomas (S.A.) and Miss A. B. C. Vines (S.A.).

The Council met in Sydney on 7th October.

Present.—The President, Mr. G. de Vahl Davis (in the chair), Miss Helen M. Wrigley (as proxy for Dr. E. T. Edwards, N.S.W.), Messrs. J. M. Vincent (Qld.), H. P. Brown (S.A.), Professor J. R. A. McMillan (A.C.T.), the Hon. General Treasurer (Mr. F. C. McCleery) and the Hon. General Secretary (Dr. F. T. Bowman).

School of Horticulture.—A request that the Institute explore the possibility of establishing a School of Horticulture within the Commonwealth was brought forward by the Tasmanian Branch in 1946. Since that time various proposals have been the subject of discussion among Branches and a sub-committee consisting of Professor J. R. A. McMillan, Mr. R. H. Anderson and Dr. F. T. Bowman have prepared a report setting forth the various suggestions that have been brought forward. The report has now been circulated to Principal Delegates with a view to discovering whether the Institute should take action on any or all of three courses proposed.

Resolutions from Eleventh General Meeting.—All seventeen resolutions from the Perth meeting were considered and appropriate action taken. A sub-committee consisting of the Hon. General Treasurer, Dr. E. T. Edwards, and Mr. J. M. Vincent was appointed to prepare a report on means of strengthening the financial position of the Institute in the light of suggestions raised at the Perth meeting. The report is to be circulated to Branches in due course.

Dealing with a resolution designed to encourage the interest of first year students in agriculture in the profession, Council resolved that one copy of each issue of the Journal of the Institute be presented to the appropriate Undergraduates' Association in each Australian University.

Several other resolutions from the Perth meeting called for the appointment of sub-committees to prepare more detailed reports for the guidance of Council and Branches, and these were also appointed.

Award of Merit.—At the August meeting of the Council the President presented the report of a sub-committee set up to correlate the opinions of Branches on the award of merit. This report reveals general agreement that the award should be made to graduates in the form of a medal or a medal and money prize, in recognition of meritorious contribution to agricultural science. Some difference of opinion exists on the precise type of service for which it should be awarded, but a majority hold the view that grounds for the award should be so wide that it recognises contributions in administration, etc., as well as in research. In other words, wide enough to cover any member of the Institute.

A name for the award has not yet been finally agreed upon, but Council decided to obtain designs for a medal from interested firms and to call for nominations for the first award.

Membership.—The following were admitted as corporate members: Messrs. J. R. Rayner (Tas.), G. Alexander, D. E. Harrison, N. C. Killeen, G. T. O'Loughlin, Miss J. Robinson, Mr. H. C. H. Watson (Vic.).

The resignation of Mr. A. G. Lowndes (N.S.W.) was accepted with regret. Mr. R. L. Crocker (S.A.) was granted honorary membership for the term of his travelling scholarship abroad.

MEETINGS OF BRANCHES.

Queensland Branch.

The meeting of the Queensland Branch on 23rd July was devoted to notes and exhibits. Mr. S. Saint-Smith discussed "rubberiness" in bananas, pointing out that the condition appeared to be confined to fruit coming from young plantations during the cooler weather; the trouble appears to be due to some upset in the ripening processes of the fruit, which, instead of softening, becomes tough and rubbery. The effect on the market for bananas is twofold; firstly, the affected fruit is inedible, and secondly, the consumer victim is likely to be wary concerning the next purchase of bananas. A brief article on the use of "Gammexane" by Mr. J. H. Buzacott of Gordonvale, N.Q., was presented by Mr. W. J. S. Sloan; it will appear in a future issue. Mr. C. G. Hughes discussed the use of mercurial compounds as an aid to the germination of sugar-cane cuttings.

In outlining the present position with regard to the use of mercurial stimulants in the cane fields, Mr. Hughes pointed out that the cane sett, seed-piece or cutting, is a length of succulent stem with end-surfaces formed of wounded cells which are incapable of producing a protective callus. Germination is largely a race between the live buds trying to get away and form their own root systems, and the soil organisms rotting the tissues of the sett. Under normal conditions the buds come away successfully and a satisfactory "strike" is obtained. However, should conditions be adverse, as when the soil is too cold, too dry, too wet or the setts are too deeply covered, the buds do not grow and "misses" result in the field. These may be so serious as to necessitate ploughing out and replanting the field—a costly item. Farmers are frequently forced to plant at a time when they know there is a risk of failure and it is then that the organic mercurial compounds can save considerable losses. No special compound has been developed for use with cane but several well-known commercial fungicides have proved satisfactory.

Soaking setts in solutions containing 0·003 per cent. mercury for six hours or more was found to give a marked response in quicker and surer germination and in the control of the pineapple disease organism (*Thielaviopsis paradoxa*), one of the most active sett invaders. This method, however, is not generally practicable under Queensland conditions. It is fortunate that a quick dip of only a few minutes in a solution containing 0·015 per cent. mercury appears to have much the same effect as soaking in the weaker solution.

Experiments under way at the present time have been designed to ascertain the effect of variation in time of dipping and whether the dipping of the whole stick prior to its planting through the cutter-planter would be effective. The plots are sufficiently large for harvestable results.

Already some farmers in areas of known unreliable germination are treating setts for planting and two farmers in the Burdekin area recently treated sufficient setts for 42 acres, i.e. approximately 90 tons of plants. Mention of the quantities of plants involved should emphasize the fact that the treating of cane setts for even very small areas is not a matter for the barrel-treatment.

At a meeting held on 27th August, Mr. T. McKnight gave an address on the free-living, nitrogen-fixing bacteria. Three groups of free-living organisms are known to fix nitrogen, viz. Azotobacter, Clostridia and blue-green algæ. A study of the occurrence of Azotobacter and Clostridia in Queensland soils was made and the environmental factors which might have a bearing on their incidence examined. Over 400 soil samples were tested for Azotobacter and 200 for Clostridia. Comparative work with three methods for the isolation of Azotobacter showed that Beijerinck's solution was more sensitive than the soil plaque method, while the agar plate was satisfactory for detecting numbers greater than 20 per gm.

Following is a summary of the effects of various environmental factors on the incidence of Azotobacter in soils from south-eastern Queensland :

pH. Was found to be a major factor governing the occurrence of the organism. The percentage of positive determinations in soils with pH values below 5·9 was significantly lower than in soils with a higher pH.

Moisture. A significantly lower percentage of positive determinations was obtained when the soil moisture was below 10 per cent. but there was no evidence of significant variation for various soil moisture ranges above that figure.

Soil Type. An increasing number of positive samples was recorded in the order—sands, sandy loams, loams, clay loams, with the black earths particularly rich in Azotobacter. The organism may be present in the grey-brown soils of western Queensland, but is generally absent from granitic sands, weakly podsolized coastal soils and the red earths.

Ploughing in of Rhodes Grass. In a fertile alluvial soil higher numbers of Azotobacter were recorded over a period of two years after Rhodes grass had been ploughed in than in the same soil not so treated. A tendency for an inverse relationship between soil nitrate and Azotobacter numbers was detected.

Clostridia were found in all soils examined.

Mr. McKnight mentioned that no measurable differences were secured in pot tests designed to show whether Azotobacter, alone or in association with Rhizobium, have a beneficial effect on legumes.

The meeting on 24th September took the form of a discussion on the soils of north Queensland, led by Professor L. J. H. Teakle, who had just returned from an extensive tour through much of the north Queensland agricultural country, particularly that of the Atherton Tableland. Since the Branch President, Mr. D. O. Atherton, was a member of a recent expedition to the Gulf country and surrounding areas and, in addition, had lived for some years in north Queensland, he was able to give details of districts not visited by Professor Teakle. These two speakers provided much information on that rather isolated portion of Australia.

South Australian Branch.

At a meeting on 31st October, Dr. D. J. Watson spoke on " Some Current Problems of Crop Production in England ". Dr. Watson is Crop Physiologist at the Rothamsted Experimental Station and with his wife, Dr. Marion Watson, is spending some months at the Waite Institute looking into Australian conditions and problems.

Dr. Watson in introducing his subject, outlined the difficulties facing English agriculture at the outbreak of the recent war. The necessity for increased production was faced by :

(*a*) increasing the area devoted to cropping, and

(*b*) increasing the level of production.

Increase in area was affected by ploughing up grassland areas, but production on these areas and intensification generally were limited by fertiliser supplies ; particularly of potash and phosphates. These shortages led to the survey of all fertiliser experiments conducted since 1900 and the best possible use of fertilisers available was based on this survey. Dr. Watson then went on to consider the position regarding particular crops.

With wheat the amount of nitrogenous fertiliser used increased enormously, but crops, generally long strawed varieties, tended to lodge badly : a problem which is being investigated at present by plant breeders. Eye-spot lodging (*Cercosporella herpotrichioides*) became a very common disease and attempts were made to control it by the use of sulphuric acid sprays. Weeds and wire worms which were particularly bad for two to three years after ploughing up grassland. were two other serious problems.

Much research work had been done on the spread of potato viruses. The Colorado beetle became an increasing menace from Europe and inspectors were constantly patrolling the Channel coast using carbon tetrachloride to fumigate areas where outbreaks occurred.

With sugar beet an interesting development had been the use of common salt as a fertiliser ; it increased yields considerably. Apparently the dressings had had no deleterious effects on soil

structure. "Yellows", a virus disease of beets, was first described in England in 1942, and in 1944 it was a serious disease. Work is being done on seed infection and growing seed plants and seedlings in areas remote from the main production areas.

The production of field beans (*V. faba*) became unpopular with farmers, as they did not understand the problems involved. Work is being carried out to determine the optimal conditions for growth.

Referring to future possibilities, Dr. Watson said that the ploughed grassland areas would not go back to grass until the present shortages are met. When that occurs wheat and potato production will decrease and animal production increase. Potassic and phosphate fertilisers must be used plentifully to build up soil fertility since England will have to rely more and more on home-grown fodder for animal production. Ley farming with a few years of grass and then a few years of cropping will be widely practised, but it will be associated with difficulties of fencing.

Victorian Branch.

On 5th September, Mr. R. W. Spicer, of the Shell Co. of Aust. Ltd., gave an address on "Recent Developments in Insecticides and their Application". Tremendous impetus was given to the development of new insecticides by the shortages and urgent needs arising out of the war, said Mr. Spicer. Efforts made to develop them met with real success, the most remarkable, perhaps, being D.D.T. However, a number of important problems involving their use had arisen. The most outstanding was the effect of insecticides in disturbing the whole biological complex, particulrly the destruction of beneficial insects. Such a case occurred in California, where the use of D.D.T. on citrus led to an enormous increase in cottony cushion scale because of the incidental destruction of the vedalia ladybird.

The influence of the newer insecticides was also being felt in the design of equipment for their application. Despite these influences it should be pointed out that the chemist was not replacing the entomologist, but the two should work more closely together than hitherto.

In searching for newer insecticides, it had not been possible to determine any fixed relationship between chemical constitution and toxicity, said Mr. Spicer. Work along these lines had been most disappointing in most cases since spatial configuration completely overweighed general considerations of chemical constitution.

Recent Insecticidal Developments.

Petroleum Oils: The work of Chapman and Pearce at the New York (State) Experimental Station is important, as it indicates that increased effectiveness and safety can be expected from use of the more paraffinic type petroleum oils. The increased effectiveness of the paraffinic types, however, had yet to be demonstrated against orchard mites. Important developments had also occurred whereby the gas oil fractions of crude petroleum were being used as solvents for toxicants such as D.D.T., gammexane, pyrethrum, rotenone, etc., which might then be applied to plants as a directly atomised mist. This type of insecticide had been used mainly in airplane application, but equipment had been developed recently for its use in ground machines on vegetable and row crops.

D-D. Mixture: This was a soil fumigant which was effective against a variety of soil insects such as wireworms, but had been used mainly to control plant parasitic nematodes. The need for expanding knowledge of nematodes was considered to be both urgent and neglected.

D.D.T.: As previously indicated, there were important problems associated with the use of D.D.T., particularly as a result of the effect on parasites and predators. It did not appear to be a serious hazard to bee populations and its residue apparently was less of a menace to public health than was at first thought. The principal groups of insects controlled were listed, and reference was made to various derivatives.

Hexa-chlor-cyclo-hexane or Benzene Hexachloride: The gamma isomer of this material had proved to be exceptionally effective against grasshoppers and a variety of coleopterous insects, including such important ones as the grain weevils, the cotton boll weevil, flea beetles, etc. Its use at present was limited to some extent by the unpleasant odour associated with the technical product.

Hexa-ethyl-tetra-phosphate: This material and the lesser known tetra-ethyl-pyro-phosphate were amazingly effective against aphids and mites, the tetra-phosphate being developed originally as a nicotine substitute in Germany during the war. They suffered from some serious disadvantages, including their rapid hydrolysis, corrosive nature and lack of ovicidal value. Repeated applications might be necessary, but they might well provide extremely helpful weapons to the farmer.

Other newer compounds briefly referred to were 4-dichlor-phenoxy-methane, which had shown great promise for citrus red spider but had been less effective against mites on deciduous trees; velsicol 1068, chlorinated poly-methylated naphthalenes, outstanding for the control of grasshoppers and cockroaches; toxaphene, a chlorinated terpene similar to D.D.T. but with less persistence-value. Brief mention was made of synergists for pyrethrum, including sesamine, N-isobutyl-undecylen-amide and piperonyl-cyclo-hexanone.

Recent Developments in Equipment.

These had largely been directed by the need to conserve labour but had been influenced to some extent by the poorer quality of agricultural labour which had suggested the elimination of the human factor in insecticide application. The need for speed and timeliness had also exerted an influence.

Developments could be traced from the conventional type equipment to the use of fixed booms and thence to various mechanically oscillating booms. Development beyond this stage had depended upon harnessing air blast with which to carry the insecticide through the crop being treated, and this in turn has led to the use of an air blast to replace the water formerly used as a vehicle for insecticides. As a result of these modifications, particularly the elimination of water, equipment could now be built which was both lighter in construction and of larger capacity.

Mention was also made of gas propelled aerosols and thermally generated aerosols and their possible applications to the problem of applying agricultural insecticides to crops.

Western Australian Branch.

On the 4th July, 1947, Professor H. C. Trumble, of the University of Adelaide, addressed a general meeting on " Some Factors Affecting the Nutrition of Herbage Plants ".

The nutrition of herbage plants provides a subject for research which is comparatively new and unusually complex. Nutritional studies have usually been conducted with single varieties of one species ; fruit and vegetable crops, cereals or fibre-producing crops such as the cotton plant and flax have, for the most part, been investigated. The plant material in these cases has been more or less homogenous, and the cultivated soils devoted to its production generally show less variation than those devoted to pastures.

In grassland work an association of species is implicit and the simplest form that can be accepted as a basic unit capable of sustained productivity is that of a grass with a legume. There is frequently an assembly of types within the species, and the range of edapho-climatic conditions under which a single association may be used is likely to be wide ; in all cases the grazing factor must be taken into consideration, and this may vary widely according to the management employed.

Nutritional studies of herbage plants should be orientated to the eventual development of a grass-legume association, and while necessarily directed in the first event to the properties of single species or strains, must take into account the interactions between the essential constituents of a pasture association under commonly employed forms of grazing.

Before the nutrition of pasture associations can be effectively examined, the conditions of both climate and soil under which these associations are growing need to be measured and understood, with particular reference to the primary physical factors of moisture, temperature and light. The only satisfactory basis on which these measures can be constructed is that of time. It is necessary to know the periods over which soil moisture is available to the plant, the fluctuations in the amounts of moisture at different depths of the soil profile and the conditions of temperature and light that obtain over the period or periods for which soil moisture is available.

Some examples of the interactions between the conditions of soil moisture, temperature and light on the one hand, and the amount or concentration of particular nutrients gained by the plant on the other hand, were then given.

The availability of phosphorus to the plant is lower with increasing dryness of the soil, leading to a reduced phosphate content as compared with a higher nitrogen content under comparatively dry conditions. The availability of phosphorus to the plant appears to increase with rising temperatures and/or improved light. The availability of potash and zinc is governed in part at least by the duration of the daily period of light.

The availability of copper, zinc, manganese and molybdenum in each case is affected by the pH of the soil, molybdenum differing from the others in being more readily available as the pH of the soil increases. Under pasture, with an acid reaction of the soil, the availability of manganese may rise to a condition of manganese toxicity.

Some species, or strains of the one species, are capable of absorbing greater amounts of particular nutrients from the soil than others. Similarly, certain species of strains are especially sensitive to the application of specific nutrients.

The investigation of soil deficiencies likely to affect pastures depends then on the accurate analysis of the edapho-climatic complex in a physical sense, and the determination of the grassland association best able to fit this complex if there are no limiting nutritional factors.

The next step is the discovery of strains which will best fit the physical complex and which either can absorb the necessary nutrients from the soil or are capable of responding to economic amounts of deficient minerals artificially applied.

The determination of the minerals most likely to be needed can best be determined in four separate steps : (*a*) field survey ; (*b*) controlled exploratory pot culture tests ; (*c*) the field test ; and (*d*) the application of the field test to practical conditions of husbandry.

Current Notes and News

Refresher Course Arranged by Victorian Branch.

Seventy members attended the refresher course arranged by the Victorian Branch. There was one each from Canberra and South Australia and three from New South Wales. Six Queensland members sent requests for summaries of the lectures provided for members who could not attend and who applied. The cost of the course was 5/- a lecture or £1/1/- for the series of 14.

The lecturers and their subjects were: Associate Professor Leeper, colloids, potash and phosphorus, nitrogen and climatology; Mr. F. Penman, soil surveys; Mr. V. B. D. Skerman, soil bacteriology; Professor J. S. Turner, physiology of flowering, nitrate metabolism and the ecological approach to plant competition; Mr. C. J. R. Gorrie, animal problems; Mr. A. R. Raw, modern plant breeding and genetics; Mr. R. R. Pennefather, extension work; Dr. J. W. Lugg, bio-chemistry.

Included in the course was an excursion to the orchard property run by Die Casters Ltd., of Officer, where the managing director, Mr. R. W. Newton, described the latest developments with his system of automatic spray irrigation which he invented. Main features of the demonstrational installation are that the equipment is permanently in position, each spray works for a predetermined period in rotational order, each spray head covers an acre and labour is eliminated.

A dinner was held during the week, when the chief speakers were the Federal President, Mr. G. De Vahl Davis; the Victorian Branch President, Mr. A. C. T. Hewitt; Mr. P. T. Kelynack, President of the Australian Veterinary Association; and Mr. G. C. Howey, President of the Australian Dairyfarmers' Federation.

Appointment of Chief of Division of Soils.

Following upon Professor Prescott's retirement from the Division of Soils, Council for Scientific and Industrial Research, which we announced recently, Mr. J. K. Taylor has been appointed to the position of Chief. Mr. Taylor is 48 years of age and has been Deputy Chief of the Division since 1943. He graduated in 1920 at the University of Sydney with the degree of B.Sc.Agr. He was a Walter and Eliza Hall Fellow from 1921 to 1923 and during that time carried out post-graduate research at Sydney and at the University of California, where he gained his M.S. degree. In 1924 he became Lecturer in Bacteriology at Hawkesbury Agricultural College, and in 1927 was appointed to the newly created Division of Soils, to initiate soil survey work on the Murray River. Since that time the activities of the Division have developed greatly, and Mr. Taylor now takes charge of a staff working on soil surveys, soil physics, soil chemistry and soil bacteriology.

Honour for Professor J. A. Prescott.

The appearance of Professor Prescott's name in the King's Birthday Honours list for the award of C.B.E. gave his colleagues much pleasure. It also affords evidence that Professor Prescott's services to Australian agriculture, to which brief reference was made in a previous issue of this Journal (Vol. 12, p. 117), have been recognised in a wider field. Members of the Institute, of which Professor Prescott is a Past President, realise that the honour is well deserved and offer their warm congratulations.

Freedom in Change of Employment.

Reference to the report on the interchange of scientific personnel which appears on page 161 of this number reveals that wide different employers exist between different employers in respect to the transfer of rights which may have accrued to an agricultural scientist as a result of his previous employment. As has been pointed out in the report, the Commonwealth services, with its provisions, if not always in practice, approaches most closely the adoption of an equitable arrangement for freedom of interchange of personnel. The provisions made by the South Australian Government are almost equally as good as those of the Commonwealth, but with other employers it is much less satisfactory.

At the eleventh general meeting in Perth the question of freedom of interchange of scientific officers came forward, and since the Premiers' Conference was then sitting in Canberra, it was resolved that a telegram be despatched to the Secretary of the Conference in support of the Institute's views. Subsequently it was learnt that the Prime Minister had announced at the Conference that the matter had been the subject of satisfactory consultation between the Premiers and the item had therefore been withdrawn from the agenda of the Conference. However, the Council so far has not obtained details of the " satisfactory consultation ", and further enquiries are being made.

Book Review

ELEMENTS OF TROPICAL SOIL SCIENCE,

by T. Eden.

(*Macmillan and Co., London*, 1947. 136 *pp. Price* 5/- *sterling.*)

Dr. Eden has written this book primarily for the planter and farmer. However, it should provide an excellent introduction to soil science for the student as well. The origin and formation of soil, and its chemical and physical properties, are covered in four chapters, which give a simple but up-to-date treatment of the subject. There are additional chapters on green manuring and composting, cultivation, soil erosion and drainage, fertilisers. A final chapter on field experiments should provide a useful introduction to farmers of methods which often appear unnecessarily complicated to them.

The book will be of interest to readers in temperate as well as tropical regions. The first four chapters cover principles of general application. Only in the final chapters is any emphasis given to tropical conditions.

T. J. Marshall.

Personal Notes

Professor S. M. Wadham was recently awarded the Farrer Memorial Medal for distinguished service in agricultural research. The presentation was made by Dr. R. J. Noble.

Professor G. A. Currie delivered one of two Macrossan Memorial Lectures at the Queensland University in September. The title of his lecture was " A Scientist in Search of Education ".

Mr. G. K. Baron Hay returned to Perth at the end of October after having attended as an Australian delegate the United Nations Food and Agriculture Conference in Geneva.

Mr. G. Loftus Hills has been appointed officer-in-charge of the dairy research section of C.S.I.R.

Mr. H. G. Turner is visiting Missouri and Minnesota on a C.S.I.R. research scholarship.

Mr. F. King, officer-in-charge, Chemical Products Department, Shell Co. of Australia, is on a seven months' tour of America and England to study latest developments on the chemical side of the oil industry.

Mr. L. R. Scharp, of the Maffra Co-Op. Dairy Products Co. Ltd., has been abroad on dairy technological matters.

Mr. W. Hartley left in October on a six months' joint American-Australian Plant Expedition, which will look for useful fodder and pasture plants in Argentina and Brazil.

Mr. G. McIntyre left by the *Orion* in November for England. He will spend nine months there, working at Rothamsted and in other centres.

Mr. R. G. Downes, of the Soils Division, C.S.I.R., has now established a unit of the Soils Division in Canberra, situated in the laboratories of the Division of Plant Industry.

Mr. N. E. H. Caldwell has been appointed to the position of Assistant Director of Horticulture in the Queensland Department of Agriculture and Stock.

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* As at 30th June, 1947, with changes where known by Editor up to 30th September, 1947.

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